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INERTIA OF MATTER.

A contribution to the theory of the inertia of matter is furnished by Messrs. Houston and Kennelly and printed elsewhere in this issue. The subject as treated by the authors is based upon the supposition that all molecules of matter are either permanently magnetized or permanently electrified. Starting with a permanent magnet moving with a given velocity, they conclude that besides the mechanical inertia which it possesses due to its motion as a moving body, it at the same time possesses electromagnetic inertia due to its magnetic flux, and therefore a certain amount of energy would be required to set it in motion and a definite amount of work done in its retardation, the energy being stored in the surrounding medium. There is every reason to believe that energy depends upon motion of matter, and, although it may exist as a strain in the ether representing potential energy, this must in turn in some way depend upon motion. It is, however, not so easy to believe that all matter is permanently electrified, and that the inertia of matter is of an electromagnetic type. The authors conceive of matter composed of molecular dynamos, having closed circuits through the ether, and owing to the powerful charge which each molecule possesses, the mass in motion will generate in the ether an electromagnetic flux proportional to the velocity, the inertia varying as the square of velocity. The hypothesis requires that the ether be devoid of inertia, since it is to the disturbance of the latter that the appearance of inertia is due. The ideas presented are novel and the article furnishes interesting reading, although the demonstration is not likely to be received as conclusive.

THE CONVERSION OF THE ENERGY OF CARBON.

At a joint meeting of the chemical and electrical sections of the Franklin Institute on May 26, an exceptionally interesting paper on the "Transformation of the Energy of Carbon Into Other Available Forms" was read by Mr. C. J. Reed and illustrated by experiments. An abstract of the paper will be given in our columns in a subsequent issue. The experiments performed by Mr. Reed were so convincing in their character that we are at a loss to explain the results of tests hitherto published setting forth the action and efficiency of the so-called "carbon-consuming battery" of Dr. Jacques. As this cell was originally described, it consisted of an iron vessel in which caustic soda was fused by external application of heat. Into this fused mass a stick of carbon was placed, and through an iron pipe plunged nearly to the bottom of the vessel a blast of air was forced for the purpose of supplying oxygen to be utilized in the combustion of the carbon. The experiments of Mr. Reed showed, however, that the carbon rod acted merely as a conductor, and could be replaced by brass, copper, German silver and other metals, or even by iron without materially affecting the result. Furthermore, it was shown that a jet of illuminating gas forced through the melted bath of caustic alkali, in place of the air, gives practically the same results, thus indicating apparently that the only function of the gas or air is to keep the upper layer of the fused caustic cool, instead of supplying oxygen for the combustion. Mr. Reed found that good carbons, such as arc light carbons, suffer no apparent change, while ordinary battery carbons rapidly disintegrated, owing, doubtless, to the action of the fused alkali on the impurities of the carbon. In another experiment it was shown that at low temperatures the carbon was positive to the iron, while at temperatures above about 350 degrees C. the carbon was negative to the iron. The well-known phenomena of reversal of the E. M. F. in thermoelectric couples

was here produced; the E. M. F. diminished as the temperature increased until the neutral or reversing point was reached and then it increased in the opposite direction. This seemed to prove conclusively that the E. M. F. could not be of galvanic origin. Mr. Reed stated that even better thermo-electric effects could be obtained by the use of potassic nitrate, instead of caustic alkali; that he had obtained from such a cell as high as 1.1 volts, and that the potassic nitrate did not at the temperature employed undergo any deterioration, while the caustic alkalies not only deteriorate, but gradually convert the iron vessel into an alkaline ferrate. The type of battery for which Dr. Jacques claims the invention, by no means deserves to be condemned on account of the apparently conclusive proof that its action is thermo-electric and not electrolytic. It is possible also that by the use of an oxide of magnesium for the purpose of conveying the oxygen the action is materially changed. At any rate, it must be considered as an advance in the art to obtain about 16 amperes at nine tenths of a volt for a considerable period of time from a thermo-electric couple.

NEGATIVE RESISTANCE.

It is difficult to see the necessity for the introduction of the idea of negative resistance in the electric arc, notwithstanding the fact that under certain conditions a small increase in voltage is accompanied by a decrease in current, thereby making the ratio of potential difference to current expressed as $\frac{\delta V}{\delta C}$ a negative quantity. Owing to the fact that the conditions of counter E. M. F., resistance and temperature are entirely changed, due to the change in the terminal difference of potential, the expression $\frac{\delta V}{\delta C}$ does not necessarily represent a resistance, and inasmuch as the counter E. M. F. may be considered as consisting of two parts, one being a function of the temperature of volatilization of the carbon, and therefore a constant for constant temperature, and the other depending upon a thermo-electric couple consisting of the electrode and its vapor and dependent upon the difference in temperature between the electrodes, it would follow that these two components might be combined and the resistance of the arc could then be expressed in the simple form applicable to motors. This form will then represent what may be strictly called a real resistance, in the overcoming of which heat is produced and not absorbed. The method employed by Messrs. Frith and Rodgers seems to be practically the same as that adopted by Mr. Freedman in his experiments, the results of which were published several months ago. These experiments and, in fact, most others seem to leave no room to doubt the existence of a counter E. M. F.

PHOSPHORESCENT LIGHTING.

Spurred perhaps by the recent public exhibition of the vacuum tube lighting of Mr. Moore, Mr. Edison is reported to be assiduously at work on a new method lately devised and consisting in the principle of a simple vacuum tube lined on the interior with a phosphorescent material and then exhausted to the required degree for obtaining the best effects when subjected to the action of an induction coil. This system, like that employed by Mr. Moore, has undoubtedly the possibility of producing effects sufficient for the purpose of laboratory experiments, but the problem is one of commercial lighting. In Mr. Edison's method many difficulties are in the way, the most important of which is the life of the phosphorescent material. This has always been the chief difficulty to be overcome in this method of vacuum-tube construction, owing to the fact that the substance will not maintain its phosphorescent property after long-continued action. The expense of constructing this type of tube is also important, and for commercial adaptation the use of the induction coil would doubtless have to be dispensed with. Mr. Edison, it is said, has stated that the terminal voltage at the tubes used in this manner need be but very low, and if this is the case ordinary commercial voltages could be used. The problem is one in which Mr. Edison will delight, as the difficulties are practical rather than theoretical, and it is probable that the work will involve his most earnest efforts. This method of lighting by phosphorescence has generally been considered as being the possible solution of the cold-light problem.

THE LAW OF INVERSE SQUARES.

We notice that in an article in the *American Journal of Science* for June, Prof. Mayer gives the results of some experiments performed for the purpose of demonstrating that the Röntgen rays follow the law of inverse squares. A sensitive plate was exposed for 30 minutes to the rays at a distance of 10 inches from the tube. A similar plate was exposed at a distance of 20 inches for two hours. The two plates taken from the same box and developed at the same time in the same tray were found to be exactly alike, the image of the wire netting which had been placed before both showing with the same intensity in both cases. From this experiment Prof. Mayer concludes that the actinic power of Röntgen rays is not sensibly absorbed by traversing air; also that the rays are not sensibly diffused by radiation from the molecules of the air they traverse, deductions which, however, are at variance with the facts observed by Dr. Pupin, Prof. Elihu Thomson and others, who have noticed diffusion when employing the fluorescent screen. Owing to this discrepancy, the experiment performed by Prof. Mayer will doubtless be received with considerable doubt, and inasmuch as a tube was employed containing a piece of calcined shell it is not impossible that the results obtained were due to ultra-violet light much nearer the visible end of the spectrum than Röntgen rays produced by the more common forms of tube. At any rate, there is every reason to believe if the experiments thus far performed can be relied upon, that Röntgen rays are not homogeneous in their character, and that effects obtained by one experimenter under certain conditions may be totally at variance with the results obtained by another, employing different apparatus and methods of operation.

Harder Than Diamond.

A substance harder than the diamond is reported to have been discovered by M. Moissan. According to a note in *Nature*, it is in the form of a compound of carbon and boron, produced by heating boracic acid and carbon in an electric furnace. The compound is black and somewhat resembles graphite in appearance. It is said to be producable in any size, and will cut diamonds without difficulty. Such a substance would be likely to find many uses in the industrial arts.

Universality of the Telephone.

Queen Victoria, it is stated, has permitted the installation of the telephone at Windsor Castle, Osborne House, Balmoral and Buckingham Palace. The Pope also favors the telephone, and has had it installed in the Vatican. It is stated that he has gone so far as to permit confessions by telephone, but priests are forbidden to grant absolution by telephone.

Appropriate.

The law in France referring to the legal adoption of the electrical units is signed by the Minister of Commerce, etc., whose name, when translated, happens to be Mr. G. Measurer.

Recovery of Tin from Scrap.

Mr. Swinburne, of London, in a recent lecture stated that it was easy enough to recover tin from scrap electrolytically in a solution of hot caustic, but the difficulty was to find the scrap from which to skin the tin, as no one seemed to have any for sale.

The St. Louis Disaster.

The disastrous storm in St. Louis, on May 27, wrought great damage to telegraph, telephone, electric light and electric railway wires. After the storm had passed over and some conception of the damage done had been learned, Mayor Walbridge ordered all electric current shut off to avoid injury to persons coming in accidental contact with broken wires. The absence of electric light rendered difficult the work of the rescuers, particularly in the outlying districts.

All of the telegraph wires on the great Eads bridge were broken when that structure was damaged by the storm, and all telegraphic communication between the city and the outside world by that route was entirely suspended.

The power house of the Scullin line, at Jefferson and Gayer Avenues, was destroyed, and several employees injured. The force of the wind was so great that, in some instances, the trolley poles on the Southwestern Electric line were bent over to the ground, without breaking.

Many of the streets were partially blocked with entangled masses of electric wires; poles were blown down and some snapped in two, allowing the cross-arms and unbroken wires to dangle over the streets.

Circuit of the Depew-Adams Telegram.

The accompaning information pertaining to the route and distance covered by the Depew-Adams message sent May 16, 1896, has been furnished by Mr. F. W. Jones for the lines covered by the Postal Telegraph Cable Company, and by Mr. George Clapperto, superintendent of the Commercial Cables, for the distance between London and Tokio:

New York *via* Meadville, Pa., Chicago, Kansas City, Albuquerque, Los Angeles to San Francisco, 4118 :: iles.

San Francisco *via* Vancouver, Winnipeg, Montreal to Canso, 4914 miles.

Canso to London *via* Commercial Cables and Waterville, Ireland, 2823. London to New York, 3663.

Total distance covered by message in four minutes, 15,518 miles.

The message from New York to Tokio, Japan, traveled as follows;

New York to San Francisco	4,118	miles.
San Francisco to Canso	4,914	"
Canso to London	2,823	"
London to Tokio	13,677	"
Tokio to London	13,677	"
London to New York	3,663	"
Total	42,872	"

and covered the entire distance over the Postal Telegraph Cable Company's system besides a large number of foreign independent connections in 57 minutes.

Death-Blow to New York Rapid Transit.

The Appellate Division of the Supreme Court has ruled adversely to the underground railway proposed in New York. Justice Van Brunt in a lengthy and forcible statement on the subject held that the city could not stand the expense and that other necessary improvements would have to be foregone should the rapid transit system be started. The estimated expenditure is stated to be mere conjecture and under the circumstances it would be very unwise to attempt a project upon which the vital matter of finances was so visionary The decision was not concurred in by Justice Rumsey. This ruling does not decide the question of constitutionality, but simply holds that the city is unable to stand the expense. It is pretty universally admitted by the Rapid Transit Commissioners that the decision is a death-blow to the present plan of rapid transit, but there is no reason why other plans should not be perfected and submitted. A special meeting of the commissioners was called and the commissioners' counsel was directed to examine the decision and present a report. The officials of the Manhattan Elevated Railway Company, the Metropolitan Traction Company and other surface lines were of course delighted and the effect of the decision was very noticeable by a jump in the stock of these companies on the Exchange. Before this decision was handed down the prospects for the immediate realization of rapid transit were exceedingly bright. Gov. Morton had signed the bills before the Legislature concerning the matter and really nothing more than a favorable decision from the Appellate Division of the Supreme Court was necessary before the ground could actually be turned and the enterprise started fairly on its way. As the decision rests on points of fact and not on points of law there is no appeal.

The New State Tax Law.

The bill recently signed by Gov. Morton revising the tax laws of New York State seems to lay more stress upon some features and affect more materially the electrical than any other interest. It provides that the Tax Commissioners, who constitute the State Board of Equalization, shall have the power of increasing or diminishing the valuation of real property in any county so as to produce a just relation between the valuations of real property in the State. The law imposes a franchise tax on transportation and transmission corporations and associations, requiring each to pay an annual excise tax or license fee which shall be equal to ½ of 1 per cent. of its gross earnings within the State, including gross earnings from its transportation and transmission business, originating and terminating within the State, but not including earnings derived from business of an interstate character. Corporations, joint stock companies or associations owning elevated or surface railways not operated by steam, shall pay to the State for the privilege of exercising its corporate franchises and carrying on its business in such corporate or organized capacity within this State an annual tax of 1 per cent. upon its gross earnings from all sources within the State and 3 per cent. upon the dividends declared or paid in excess of 4 per cent upon the actual amount of paid-up capital employed by such companies. Every corporation, joint stock company or association formed for supplying water or gas, or for electric or steam heating, lighting or power purposes, shall pay to the State an annual tax which shall be ½ of 1 per cent. upon its gross earnings from all sources within the State, and 3 per cent. upon the amount of dividends declared or paid in excess of 4 per cent. upon the actual amount of paid-up capital employed by such corporation, joint stock company or association.

Liabilities of Telegraph Companies.

The Appellate Division of the Fourth Department has recently handed down two decisions which indicate considerable strictness in holding telegraph companies liable for the carelessness of their employees. In one case, a message which was sent out contained eight words, and as received at its destination contained the figure 8, but actually only seven words were delivered. The court stipulates that the company may, by contract, limit its liabilities for negligence if not gross, but it cannot limit its liability by any form of contract when its negligence is gross. It held that the company in this case was grossly negligent in the receipt and delivery of the message. In the second case, the action was suit against the company for failure to send a message. This despatch was sent by a messenger who was told to wait for an answer; the messenger, however, put it in his pocket and forgot it until the next day. The condition on the blank was that whenever a message was sent to the telegraph office by one of the company's messengers, the latter should be deemed an agent of the sender, and the court decided that this was a most remarkable regulation, and although it is undoubtedly within the power of the telegraph company, as it is of any other corporation, to make rules and regulations for the proper conduct of its business, such rules should be reasonable in their character and in accord with good, sound public policy. The one under consideration is neither. On the contrary, it was an imposition on the public and upon every patron of the defendant who had not the time and disposition to go in person to the transmitting office for the purpose of sending a message. The telegraph companies are corporations of the State. They are organized to transact business because of the pecuniary gain which they are supposed to reap from the public, and are under obligation to furnish some equivalent for the compensation thus received. If they are to be permitted to establish a regulation like the one in question, there is no reason why they should not impose upon their patrons, as a condition of transacting their business and receiving their money, the requirement that the operator and the messenger at the other end of the line should be regarded as their agents, and it consequently becomes merely a question of time, when in this manner the company shall escape the liability they still assume.

An Electromagnetic Theory of the Inertia of Matter.

BY EDWIN J. HOUSTON, PH. D., AND A. E. KENNELLY, SC. D.

It has ever been a mystery why matter should possess inertia, why it should react against moving force with a force proportional to its acceleration, and why its kinetic energy, in conformity with the latter law, should vary as the square of the velocity.

While we by no means claim to have solved this problem to the extent of demonstration, yet the following hypothesis may not be devoid of interest as offering a possible solution. We think that it is demonstrable from known electromagnetic laws, and known electrochemical effects, that matter must possess some electromagnetic inertia. Whether this electromagnetic property is sufficient to account for all the observed inertia of matter we are unable to assert, but it does not seem impossible that it should be capable of accounting for all the inertia.

It is a well-known electromagnetic law that the motion of electromagnetic flux through ether, in a direction at right angles to itself, produces in the ether a disturbance which constitutes an electromotive intensity directed at right angles to both flux and velocity, and toward the right hand of an observer, facing the direction of motion and having the flux passing from his feet to his head. Thus, if a magnet, such as is indicated diagrammatically in Fig. 1, where the

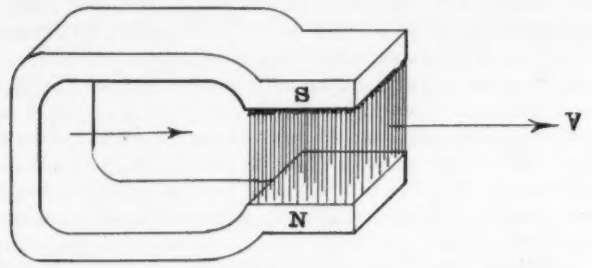


Fig. 1.

flux density, gausses, passes from the north to the south pole, as indicated by the arrows, be moving with a velocity of v cms. per second in the direction of the arrow, then the electromotive intensity is known to be developed in the ether or air in a direction upward or toward the observer at right angles to the plane of the paper, and of magnitude $\mathcal{H}_e = \mathfrak{B}v$.

This is the ordinary law upon which dynamos are constructed, except that instead of providing a conductor, along which the electromotive intensity is summed into an E. M. F., the intensity exists merely in the ether. The development of this motional system of electromotive intensity produces an electrostatic flux enveloping the poles of the magnet as it moves along, in addition to the electromagnetic flux which is present whether the magnet moves or not. But this electrostatic flux represents electrostatic energy stored in the ether surrounding the magnet. Suppose, for example, that at some particular velocity, v, the total electrostatic energy in the flux distribution surrounding the magnet amounts to one erg; then, it is evident that if we double the velocity, we everywhere double the flux density of the electrostatic flux, since the electrostatic intensity is everywhere doubled. But we know that a double electrostatic flux density in any volume of air or ether involves the existence of quadrupled energy, or, in other words, that the electrostatic energy, varies as the square of the electrostatic flux density. Consequently the total electrostatic energy in the space surrounding the moving magnet varies as the square of its velocity in the direction assumed which is here at right angles to the magnetic flux.

But this energy has not been derived from the original magnetic charge or magnetic flux of the moving magnet. It must, therefore, according to our conceptions of the conservation of energy have been obtained from the force setting the magnet in motion. Consequently, the magnet will have in addition to its mechanical inertia, an electromagnetic inertia and a kinetic energy of the type $\frac{m v^2}{2}$ where $\frac{m}{2}$, instead of being regarded as half the number of grammes mass in the body, is to be regarded as a function of the magnetic flux between its poles. In other words, if the magnet were devoid of what we commonly regard as its mechanical inertia, it would still possess a certain although a very small inertia due to the presence of its magnetic flux. A certain amount of energy would be required in order to set the magnet in motion; and, once being in motion, this energy would remain stored in the surrounding air or ether, capable of being released as a moving force when the motion of the magnet was retarded. This reactive force would follow the law of acceleration, just as does ordinary mechanical reaction.

If, therefore, it could be assumed that all the molecules of every kind of matter possessed magnetic circuits and a constant quantity of magnetic flux through all physical states and changes, it would follow that all molecules of matter would possess inertia, provided they were caused to move in a direction not coincident with the direction of the magnetic flux between them, and they would possess a maximum inertia in a direction at right angles to this magnetic flux. In any accumulation of molecules, such as a material body, the average number of molecules lying in a particular direction would always be the same, and the magnetic inertia would, therefore, always be the same unless the forces brought into play, by the motion of the molecules, oriented the magnetic circuits in a particular direction.

The actual amount of magnetic inertia which could be produced by any material magnet with which we are acquainted is almost infinitesimally small. In other words, the number of volts of E. M. F. in an electrostatic system, set up through the ether by the moving magnet, would be so small that the energy due to this voltage in the surrounding air would be insignificant compared with the energy which we regard as dynamical kinetic energy.

This, however, is not all. A corresponding group of laws applies to electrostatic flux. Thus, consider a condenser formed of two tinfoil plates separated by a dielectric such as a thin sheet of mica. These plates may be arranged either as a plane plate condenser, or, for more convenience in calculation, they may be rolled into a cylinder, or a pair of concentric cylinders, as represented in Fig. 2. If these two cylinders be connected with an E. M. F., the inner cylinder, A to the positive pole and the outer cylinder, B to the negative pole, we know that an electrostatic flux will be developed in the dielectric in radial lines between the cylinders, and this electrostatic flux will have a certain flux density $\mathfrak{B}$. If we move this electrostatic flux through air or ether at right angles to itself, in this case in a direction parallel to the axis of the cylinder, a system of magnetic forces will be set up in the dielectric everywhere at right angles to the motion and to the electrostatic flux. The general direction of these magnetic forces will in this case be in cylinders concentric to the tinfoil cylinders, and toward the left-hand of the person facing the direction of motion and having the electrostatic flux passing

Fig. 2.

through his feet to his head. This system of magnetic forces will develop a distribution of magnetic flux around the condenser in the mica dielectric and of intensity in electrostatic units $\mathfrak{B} = \frac{e \kappa \mu v}{h}$ where e is the E. M. F. between the cylinders as originally impressed in eloctrostatic units. κ is the specific inductive capacity of the mica, μ the permeability of the mica, h, the thickness of the dielectric in cms, v, the velocity of motion in centimetres per second.

Consequently, as we move the condenser forward along its axis with increasing velocity, we increase the magnetic flux density which is established in the dielectric, but each cubic centimetre will, with a flux density of $\mathfrak{B}$ gausses, contain $\frac{\mathfrak{B}^2}{8\pi\mu}$ ergs of magnetic energy. This magnetic energy has not been supplied at the expense of any of the original electrostatic energy imparted to the condenser on its charge, and, consequently, must have been derived from the forces which produced the motion. If, therefore, we double the velocity of motion, we quadruple the magnetic energy contained in the condenser, or the magnetic energy varies as the square of the velocity. This means that in setting the condenser in motion, a certain reactive E. M. F. will have to be overcome at a rate proportional to the acceleration; and, in the same way, when the condenser is arrested, it will supply a moving force out of this stock of magnetic energy proportioned to the retardation.

If, then, it can be assumed that all molecules were minute con-

densers, having an electrostatic flux which would be constant through all physical states and changes, it would follow that such molecules would possess a certain amount of inertia whereby they could only be set in motion after developing energy in the electromagnetic form in the ether surrounding them. This inertia would be zero if the motion took place in a direction coincident with all the electrostatic flux in a molecule, and would be a maximum if at right angles to all the electrostatic flux. As before, any aggregation of molecules, such as a material mass, would offer on the average, as much electrostatic inertia in one direction as another, unless it were possible to orient the directions of the molecular electrostatic fluxes.

In any actual condenser this electrostatic inertia is insignificantly small. One square centimetre of condenser, having a mica dielectric 0.01 cm thick, would have an electrostatic inertia, at a potential difference of 1000 volts, such as would be represented in mechanical units by about 6×10^{-16} gramme.

To sum up then, matter must possess inertia of an electromagnetic type if all molecules are permanently magnetized or permanently electrified. We have reason to believe that all matter is electrified. Indeed, chemical affinity is generally believed to be due to the attractions of oppositely charged ions.

Stripped of all technicalities it would appear, therefore, that the inertia of matter may possibly be accounted for by regarding matter as being composed of molecular dynamos having closed circuits through the ether. These molecules have powerful electric charges, and it is the motion of these charges through the ether that generates a magnetic flux proportionate to the velocity. When the molecules are at rest they possess electrostatic flux, but no enveloping electromagnetic flux. The electromagnetic energy must vary as the square of the velocity, and reactionary forces must be set up between the surrounding ether and the moving molecules, of the kind which exist in electromagnetic motors, tending to resist change in motion.

The questions outstanding are as to the strength and constancy of the electric charges of the atoms constituting the molecules, also as to the impossibility of orienting these charges. For, as we have seen, according to this hypothesis any orientation of all the electric charges throughout the mass would leave a certain direction in which the body should move without manifesting any inertia.

It will be seen that this theory requires that ether itself shall be devoid of inertia since it is the disturbance of the ether surrounding matter which produces the appearance of inertia in matter.

Storage Battery Manipulation on Variable Loads.

BY J. E. WOODBRIDGE.

Of all the places where a storage battery would seem to be desirable, the trolley line power station would appear to rank first and foremost.

The peculiar power of a storage battery for smoothing out the engine load, steadying the engine governors, the engine speed and steam distribution, carrying the station over peaks on the load curves, burning out shorts without opening the circuit-breakers, tiding over emergencies, enabling a 1000-kw station to meet a 2000-kw demand, and running all-night cars unaided, should make it a blessing in the railway power-house.

This blessing is pretty well disguised at present by difficulties of

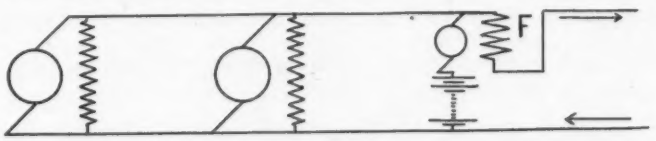


FIG. 1.

operation, which are, however, rapidly being overcome. When a storage battery is run in multiple with a dynamo on a varying load, the storage battery should be made to take a charging current when the outside load is light, and discharge the same when the load is heavy. This a simple battery will not do of itself unless the regulation of the dynamo is very poor. If that is the case the fall in voltage of the dynamo, as the load rises, will cause the battery to pick up a part of the load, and *vice versa*. If the machine is compounded for constant potential at the bus-bars, the battery will give the same current right along, no matter what the load is. If the machine is over-compounded the battery will tend to discharge when the outside load is light, and charge again when the load is heavy. This will, of course, make the engine load variations worse than though no battery was used at all.

As most power stations work with over-compounded dynamos, some method has to be adopted to overcome this trouble.

The remedy used in the lighting stations is to attach a movable contact in the battery circuit for cutting in or out some of the cells. This contact may be moved by hand, or, as has been done in some Edison stations, by automatic apparatus propelled by motors and controlled by relays sensitive to the voltage.

There are several objections to this, one of which is the well-founded objection to any form of electro-mechanical automatic regulating apparatus. Another is the trouble likely to result from the sliding contact. If this makes connection with a new commutator section before leaving the previous one, the cell or cells between the two are momentarily short-circuited; and if this is frequently repeated the cells are sure to be injured. If the sliding contact does not lap over two conducting sections in the commutator, the battery circuit is opened and closed again every time the contact moves.

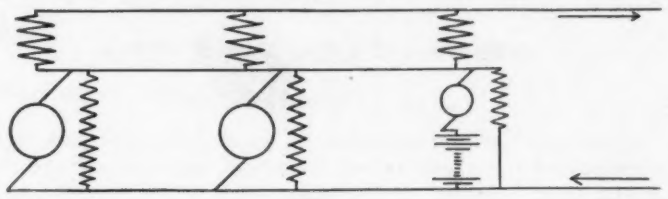


FIG. 2.

With several hundred amperes flowing in the battery circuit, this is pretty hard on the contacts.

Another and better way is to compound or over-compound the battery circuit. To do this a special low-voltage dynamo or booster should be connected up, as shown in Fig. 1, with its armature in series with the storage battery across the mains, and its fields carrying the whole outside load. Then, if the battery voltage is a little less than that of the dynamos at no load, the battery will charge when the load is light. As the load increases the extra dynamo will automatically raise the voltage in the battery circuit and cause the batteries to discharge on heavy loads. By means of a shunt to the field (F), the compounding of the battery may be adjusted as desired.

Another arrangement convenient with compound dynamos is that shown in Fig 2. Here the battery booster has its armature con-

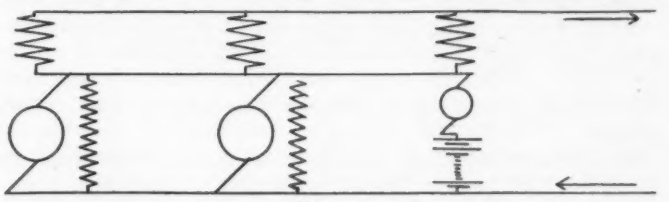


FIG. 3.

nected as before, and its field shunted in with the other series fields between the equalizer and the positive bus. This extra shunt to the series coils of the dynamos will tend to reduce their compounding, but a few leaves taken out of the shunts on their terminal slates will fix that. Then the energy previously used in heating these shunts will go to excite the fields of the battery booster.

Still another arrangement is that shown in Fig. 3. Here the battery booster is made to work both ways. A shunt winding on its field spools tends constantly to generate in its armature an E. M. F. opposed to that of the battery. The series coils on the same field tend to reverse the polarity of the machine.

When the load is light the shunt field predominates and the booster helps the main dynamos to charge the battery. With a moderate load the booster becomes idle, but with a heavy load its polarity is reversed and it helps the battery to discharge and relieve the dynamos.

With any one of these arrangements an adjustment of the series field of the battery booster, by means of shunts or by the cutting out of sections, will vary the amplitude of the range of the battery current. Just as in compound dynamos, a stronger series field will increase the duty of the battery on heavy loads, and a weaker field will diminish the same. Some other means of adjustment is necessary to properly proportion the charging and discharging currents; that is, to make the charging current for the 24 hours totalize the same as the discharge plus the battery losses. In the cases shown in Figs. 1 and 2 this can only be done by switching in or out some of the batteries by hand. This method is open to the great objection of the automatic commutator method; that is, that some of the cells are charged differently from the others, the removable cells being at times entirely discharged or perhaps reversed, and at times overcharged, according to circumstances.

This difficulty is most beautifully overcome in the scheme shown in Fig. 3. In this case the proper number of cells should be left in circuit continuously, and the adjustment made by varying the shunt field of the booster. If the battery tends on the whole to discharge, strengthen the shunt field of the booster. If it tends to overcharge, weaken the field of the booster. If only one dynamo is running, and extra work is wanted from the battery, turn down the shunt field of the booster. If plenty of machines are running, and it is decided to charge the battery in a hurry, turn the field up again, etc., etc.

The booster should never be run from a separate engine, because at times it runs as a motor. The best way to run it is to couple it direct to a shunt motor. It will then be available when the whole steam plant is shut down to regulate the voltage at the bus-bars.

Regulation of Rotary Current Motors.

BY DR. H. BEHN-ESCHENBURG.

It is known that the regulation of the starting power, the starting current and the speed of rotary current motors is, with constant binding post potential of the primary field exciting current, equally easy and simple by switching in controllable induction, free resistance in the induced system or the armature, as the regulation of direct current motors in which the field is kept at constant strength by means of an exciter, and the brush potential of which is regulated by a rheostat in the main circuit, still there are also the same certain impediments.

Such a method of controlling rotary current motors was no doubt first adopted (put into practice) by Dolivo-Dobrowsky, and application for letters-patent filed in several countries (1890). In No. 1 of the *Electro-Technischises Zeitschrift*, 1896, I have developed several formulas for the theory of this regulating (in which several apparent mistakes remain). I herewith wish to put these figures and the reasons in practical form.

In general, there exists between the speed of the motor, the resistance of the armature circuit and the torque or load moment or power of the motor the simple proportion, that the torque in kilogrammetres approximately equals (precisely speaking it is 3 per cent. less) the electrical energy in watts converted into heat due to armature resistance, divided by the difference between the synchronous and actual speed in revolutions per minute. It follows, therefore, that the efficiency of the motor is at most less than the proportion of the two speeds.

At starting the actual speed is o, at normal running the actual speed must at least be within 5 per cent. of the synchronous, and running unloaded the actual speed is practically equal to the synchronous.

The following symbols will be used:

E_1 E_2—Potential at binding posts of a primary in reference to a secondary current.

E_0—Secondary binding post potential with motor at rest and armature circuit open.

I_1 I_2—Strength of a primary in reference to a secondary current.

I_0—Primary current, running unloaded, with open armature.

I —Primary current at starting with short-circuited armature.

I_2—Secondary current at starting with short-circuited armature.

T_0—Synchronous number of revolutions running unloaded.

T—Actual number of revolutions with any load.

D—Torque of motor in kilogrammetres (pull × lever-arm).

A—Work done by motor in watts (inclusive mechanical and magnetic friction.)

s—Slip of motor.

N_1 N_2—Number of primary in reference to secondary currents of different phases (as a rule $N_1 - N_2 = 3$).

W_1 W_2—Number of windings in a phase division.

r_1 r_2—Resistance in ohms of phase division.

R—Resistance of rheostat switched into circuit of secondary phase.

We introduce the following abbreviations:

$$m = \frac{w_1^2}{w_2^2} \cdot \frac{N_1}{N_2} \left(\text{as a rule } m = \frac{w_1^2}{w_2^2} \right)$$

$s l_2 = \frac{s E_1}{m I_a}$ the apparent induction resistance of an armature phase.

The following are generally known:

$$A = 1.03\, D\, T \qquad (1)$$

$$s = \frac{To - T}{T_0} \qquad (2)$$

$$\frac{I_0}{I_a} = 1 - \frac{E_0^2\, W_1^2}{E_1^2\, W_2^2} = \sigma, \qquad (3)$$

in which σ is a measure of the magnetic diffusion in the motor.

Instead of the equation — (3) there are, practically, limits

$$\frac{I_0}{I_a} = \sigma_{\min.} \qquad 1 - \frac{E_0^2\, w_1^2}{E_1^2\, w_2^2} = \sigma_{\max.}$$

and $\sigma_{\max}$ can be almost three times as large as $\sigma_{\min.}$ The value of σ is about midway between these limits when running the motor at normal current. Now, as σ is expressed in all formulas following, by the quotient $\frac{I_0}{I_a}$, σ would in one case have too small a value when I_0 and I_a are the currents actually observed at unloaded running and starting; and on the other hand the value would be too large if $\frac{I_0}{I_a}$ is calculated from formula (3).

We will consider that this fact is taken in account for every application of this formula following:

The maximum work done by the motor with closed armature circuit is:

$$A_{\max} = \frac{N}{2} E_1 T_a \left(1-\sigma\right) \left(1 - \frac{(r_1 + m\, r_2)\, I_a}{E_1}\right) \qquad (4)$$

with a speed:

$$T_m = T_0 \left(1 - \frac{m\, r_2\, I_a}{E_1} - \frac{r_1\, r_2\, m\, I_a^2}{E_1^2}\right)$$

and the primary current:

$$I_m = \frac{I_a}{\sqrt{2}}$$

Then the motor produces the maximum torque

$$D_m = \frac{N_1\, E_1\, I_a}{2.06\, T_0} \left(1 - \frac{r_1\, I_a}{E_1}\right) \left(1 - \sigma\right) \qquad (5)$$

In general for any speed, any loading and any armature resistance, we get:

$$I_1^2 = \frac{1.03\, D\, (T_0 - T)}{N_1 m\, (1-\sigma)\, (r_2 + R)} \left(1 + \left[\frac{m\, (r_2 + R\, I_0}{S\, E_1}\right]^2\right) \qquad (6)$$

$$I_2^2 = \frac{1.03\, D\, (T_0 - T)}{N_2\, (r_2 + R)} = \frac{E_0^2\, s^2}{\left(r_2 + R + s\frac{r_1}{m}\right)^2 \left[1 + \frac{I_2^2\, s^2}{r_2 + R + \frac{s\, r_1}{m}}\right]^2} \qquad (7)$$

$$s = \frac{N_1\, I_a^2\, (1-\sigma)\, m\, (r_2 + R)}{2.06\, D\, T_0} \left(1 \pm \sqrt{1 - \frac{D^2}{D_{\max}^2}}\right) \qquad (8)$$

The starting moment of the motor with short-circuited armature is:

$$D_a = \frac{N_1\, I_a^2\, (1 - \sigma)\, m\, r_2}{1.03\, T_0} \qquad (9)$$

Here notice, that the starting moment of the motor can be different for different positions, so long as the armature resistance is small as compared with the induced resistances l_2, caused by diffusion, which applies generally for short-circuited armatures. The field is not homogeneous for every relative position of the armature gaps and field spaces, owing to these gaps or spaces in the iron cores. Therefore, a mean value of D is introduced.

By substituting D_a for its value, we simplify the formula (8) appreciably. It becomes

$$s = \frac{D_a}{2\, D} \left(1 \pm \sqrt{1 - \frac{D^2}{D_m^2}}\right) \frac{(r_2 + R)}{r_2} = \frac{T_0 - T}{T_0} \qquad (10)$$

And from it we deduce, as long as the load moment of the motor remains constant,

$$\frac{T_0 - T_a}{r_2 + R} = \text{constant.} \qquad (11)$$

I_1 and I_2 constant.

The speed varies in proportion to the armature resistance, therefore, for all speeds the current remains the same.

Therefore, when at rest or normal speed the motor is exerting a given torque, the currents in field and armature are constant; and motors which are supposed to carry the full load with less than normal current, apparently do so for want of more accurate observation.

We can next develop from formula (3), a very simple expression for the efficiency of the motor without brakeing. The motor is held at rest, and, as in the case of a transformer, the primary and second-

ary electrical energy are measured for a certain secondary load resistance R.

Thus the secondary energy is:

$$W_2 = N_2 I_2 {}^2E_2 = N_2 I_2{}^2 R,$$

and the efficiency of the motor for any output, $A = W_2$

$$\eta = \frac{W_2}{N_1 E_1 I_1} \cos \phi_1 = \frac{A}{N_1 E_1 I_1} \cos \phi^1 \qquad (12)$$

Of course in the case of a motor held stationary the loss due to mechanical friction is *nil*, but on the other hand the losses in the armature due to hysteresis are, in inverse proportion, larger than in a rotating motor, so that, as a rule, the efficiency results will be good. The drop in secondary potential of the motor transformer is deduced from:

$$E_2 = \frac{E_0}{\sqrt{\left(1 + \frac{\left(r_2 + \frac{r_1}{m}\right)}{R}\right)^2 + \frac{l_2^2}{R^2}}} \qquad (13)$$

precisely as the drop in potential of a transformer.

It is easy to figure the desired regulating resistance R for a given starting power from the formula:

$$\frac{R}{\left(1 + \frac{r_2}{R}\right)} = \frac{N_2 E_2{}^2}{1.03\ D\ T_0} \qquad (14)$$

from which we get the approximate formula:

$$\left(\frac{R}{1 + \frac{r_2}{R}}\right) = \frac{0.8 N_1 E_1{}^2}{m T_0 D}$$

The maximum starting moment is for

$$R + r_2 = l_2 = \frac{E_1}{m I_a}.$$

The maximum starting moment becomes equal to the maximum load moment (see 5), namely:

$D_m = \frac{3}{2} \frac{E_1 I_a}{1.03\ I_0} \left(1 - \frac{r_1 I_a}{E_1}\right)$ and herein the current $I_m = \frac{I_a}{\sqrt{2}}$

as also directly from (11), it appears for any given speed with given load moment the desired regulating resistance R is obtained by dividing the calculated value of R for the same starting moment by the amount of the slip S.

A simple investigation of the formula (10) for the slip S shows that for every allowable load moment an unstable and a stable condition of motion of the motor is possible.

For the unstable condition the above expression before the root applies, and is approximately:

$$s = \frac{(r_2 + R)\ D_a}{r_2\ D},$$

for the stable condition, we can say, with better approximation, as long as $D < 0.8\ D_{max}$,

$$S = \frac{r_2 + R}{r_2} \frac{D_a\ D}{4\ D^2{}_{max}} \qquad (15)$$

from which is deduced directly:

$$\frac{I_0 - I_1}{I_0 - I_2} = \frac{D_1 (r_2 + R_1)}{D_2 (r_2 + R_2)}.$$

The difference between actual and synchronous speeds of the motor increases in exact proportion with an increase of the load moment and an increase of the armature resistance.

The quotient $\frac{D}{D_{max}}$ has for practical working a simple meaning. With normal load and short-circuited armature, the slip will be very small, therefore T equals nearly T_0.

Then for normal loading the ratio $\frac{D}{D_m}$ can be considered nearly equal to the proportion of the normal output of the motor to the maximum, and therefore expresses the overloading capacity of the motor. The normal output should lie within the bounds of the maximum efficiency; for this maximum efficiency in above cited place the work done was calculated.

$$A_n = N_1 E_1 I_0 (1 - \sigma) \sqrt{\frac{A_0}{N_1 I_0{}^2 r_1}} \qquad (16)$$

A_0 represents the work done with the motor running unloaded, only overcoming friction and hysteresis; $N_1 I_0{}^2 r_1$ represents the transformed energy in the copper of primary windings when running unloaded; the relation of these we express by the coefficient C_1, and thus obtain for the overloading quotient:

$$\frac{A_n}{A_{max}} = 2\sigma\sqrt{C} = \frac{2 I_0}{I_a} \sqrt{C_1} \qquad (17)$$

We will now consider a formula for the phase difference between the binding-post potential and the current of the motor, or the quotient of the energy current in watts and the product of the simultaneous readings of current and binding-post potential.

We will designate the energy consumed by W_1 watts, then the phase difference ϕ may be defined by $W_1 = N_1 E_1 T_1 \cos \phi$.

For the determination of $\cos \phi$ the following expression for the motor characteristic may be used:

$$\frac{(r_2 + R)\ m\ T_0}{E} = \alpha.$$

From this is obtained

$$\tan \phi = \frac{\left(\frac{\alpha}{s} + \frac{s\ \sigma}{\alpha}\right)}{1 - \sigma - \frac{r_1 s}{(r_2 + R)}\ {}_m\left(1 + \frac{a^2}{s^2}\right)}. \qquad (18)$$

This expression for the phase difference becomes a minimum and at the same time the power factor becomes a maximum for

$$s = \frac{a}{\sqrt{\sigma}}.$$

For this value of the slipping s we have

$$\tan \phi_{min} = \frac{2\sqrt{\sigma}}{1 - \sigma + \frac{r_1 T_a}{r\ \sigma\ E_1}}; \quad \cos \phi_{max} = 1 - 2\sigma. \qquad (19)$$

The limiting value of the power factor $\cos \phi$ gives thus direct means of solving (3) or the diffusion coefficient σ.

For a more exact determination it is necessary to add that the maximum torque does not exactly correspond to the torque of the maximum output of the motor or the maximum secondary effects of the motor transformers. If we designate the value of the armature resistance and the slipping, for which the maximum torque enters with the subscript D and the values for which the maximum output enters with subscript A, then we have the second approximation:

$$\frac{(R + r_2)_D}{(R + r_2)_A} = \frac{S_A}{S_D} = 1 - \frac{r_2 T_a m}{E_1} \qquad (20)$$

and, of course,

$$S_A = \frac{r_2 T_a m}{E_1} \left(1 - \frac{r_2 T_a m}{E_1}\right)$$

$$(r_2 + R)_A = \frac{E_1}{T_a m} \left(1 + \frac{r_2 T_a m}{E_1}\right)$$

The Vienna Exhibition of 1883.

The International Electrical Exhibition at Vienna, held in the Summer of 1883, although interesting, and quite successful as an exhibition, was not a landmark in the development of the electrical industry. It was held at a time when the industry had gotten over the effects of the first great strides, and was being developed more in a commercial way as distinguished from speculative enterprises. The first great inventions had been made, and they had been applied long enough to show capitalists that the electrical industry was now a legitimate, attractive and profitable field for the investment of capital in factories and installations as distinguished from patents of unknown value. The object of that exhibition was therefore more to show what was being accomplished commercially than to exhibit a few striking inventions.

Its predecessor of 1881 was characterized by the first public exhibition of the incandescent light, the commercial arc lamp and the telephone, while the principal feature of the Munich exhibition, which followed the one in Paris, was the electrical transmission of power to what was then considered a great distance; but there was no such distinct exhibit at the Vienna exhibition except perhaps the first suggestion of the use of transformers in alternating-current transmission and distribution, in order to reduce the cost of the line. While this may be said to have been the first exhibit of this apparatus, it was only in embryo, and not by any means in the form of a practical system; it was then hardly more than the suggestion of Goulard and Gibbs, worked out in a crude form, as also of another inventor, whose name has not been so intimately connected with the system. The lighting system had developed sufficiently to enable those who knew something about the size and cost of mains to realize the possible advantages of high-tension transmission and subsequent reduction by means of transformers, and the new and very bold suggestion therefore received due consideration, but its practical success was by no means an assured fact at that time. Transformers were very primitive affairs and the only practical instrument for measuring alternating currents was the electro-dynamometer, whose limitations were not yet generally understood, while the theories of alternating currents and their behavior were known only to physicists and mathematicians, besides

perhaps in a general way to a few constructors. An interesting illustration of this was a small alternator called the Klemenco dynamo which had stationary armature and field coils, the only revolving part being a pair of star shaped solid (!) iron pieces which formed the field poles and which revolved in front of the cores of the armature magnets ; when this machine was run on closed circuit the transmission belt dynamometer showed a consumption of about 5 horsepower, but when the power was measured for open circuit, the exciting current remaining the same, the dynamometer read 15 horsepower and the poor little machine threatened to get red-hot. As there was no fault in the measurements, it was thought best not to waste any more time with this forerunner of one of the most prominent alternators of the present day.

Another illustration of the state of the art at that time was a test which was made to show whether an incandescent lamp was more efficient with an alternating than with a direct current. The results were of little value then, and are of none now. The importance of measuring the life of incandescent lamps was appreciated at that time, but the idea of making such a test was too formidable to receive consideration ; but the fact that it was not made then was one of the chief reasons why such a test—the first of its kind—was carried out at the following exhibition, which was held in Philadelphia in 1884. The crude method used at Vienna for obtaining what was thought to be at least an indication of the relative lives of different incandescent lamps, was to increase the voltage until the filament gave out. Such a test naturally gave results considerably in favor of the hollow filament lamp which, though quite prominent at that time, has since succumbed and is now found only in museums.

The telephone was well advanced and was exhibited by transmissions from the concert halls, theatres and opera house of the city, the clearness being very satisfactory. Among the arc lights the American lamps compared very unfavorably with those of Europe; as the latter were very steady and white, even remarkably so to an American who was used to the purple flickering lamp of those days, but with the exception of this, the American arc-lighting systems as a whole were more practical than those used in Europe.

Accumulators were represented, but did not attract any very great interest. One of the largest batteries was being "formed" during the whole time of the exhibition and was not ready to use until the exhibition was over. There was little shown in the development of the transmission of power, and what there was, was only for short distances. The electric railway was represented by a short line in which one rail was the positive and the other the negative lead, no particular pains being taken to insulate them from the sleepers; it operated, but it was thought best not to discuss the question of economy; the tracks were carefully guarded and fenced in all along the route, while at crossings the rails were cut out of circuit.

The inevitable illuminated fountain was of the primitive kind now considered out of date, in which the light was thrown down onto it from an elevated projector, but it was nevertheless quite attractive.

One of the exhibits, of some interest now, was a system of lighting which was not appreciated then nor for a number of years after and which in fact has only comparatively recently come into prominence again. It was the system of diffuse lighting, the lights themselves being completely out of sight, but so arranged as to illuminate the walls and ceilings, producing a pleasant, mellow, diffused light which cast no shadows.

Another exhibit with a somewhat similar history was the Puluj vacuum lamp, in which the so-called "cold light" was produced. It was thought at that time to be the forerunner of the solution of this most important problem, but although this was 13 years ago, little progress has yet been made.

Although the properties of electricity, at least as far as direct currents are concerned, were at that time well understood by the educated electrical engineers, the general public had yet but a vague idea of this "wonderful material," and an amusing illustration of the ignorance of even the otherwise highly educated occurred during one of the visits to the exhibition, of an Austrian dignitary. He was shown the various exhibits, accompanied by a corps of professors, who acted as his guides, and being of a mechanical turn of mind, he remarked that he would like to be shown the machine which bored those long fine holes through which the electric current passed in the wires.

Like all European exhibitions, this one was made very attractive to the public in general, and was therefore quite a success. Being one of a series of five annual electrical exhibitions and held at a time when the novelty of such exhibitions were beginning to wear off it, formed no particular landmark in the history of the electrical industry.

Notes on the Electrical Exhibition of Philadelphia of 1884.

Twelve years have elapsed since the International Electrical Exhibition of 1884 was held in Philadelphia under the auspices of the Franklin Institute of the State of Pennsylvania. It has been generally recognized that, so far as recent history of electricity in America is concerned, two important epochs existed; namely, that of the World's Centennial Exhibition, held in 1876, and the International Exhibition, above alluded to. There was, however, this difference: That while the first was a general exhibition and only partly electrical, the second was wholly electrical in its nature.

All exhibitions must necessarily result in a stimulus to invention; for by their means there are brought together, in concrete form, the products of the invention of all countries. It may be of interest, therefore, at this time, when the National Electrical Exhibition is being held in New York, to give a brief *résumé* of some of the more striking characteristics of the Philadelphia Exhibition of 1884.

The influence which the 1884 exhibition exerted in the electric art and science was increased by the fact that there was held during the progress of this exhibition a national conference of electricians, held under the auspices of a commission appointed by the United States Government, by act of Congress in May, 1884. This Commission consisted of H. A. Rowland, G. F. Barker, Simon Newcomb, C. F. Brackett, J. W. Gibbs, John Trowbridge, F. C. Vandyke, C. A. Young, M. B. Snyder, Edwin J. Houston, W. H. Wahl and R. A. Fiske. During this conference, which included both the theoretical and practical ranks of workers, many valuable papers were read.

Both the papers and the discussions which followed them proved so valuable and suggestive that there finally grew out of this national conference a society which to-day holds the first rank in the electrical profession in the United States; namely, the American Institute of Electrical Engineers, whose first meeting was held in the exhibition hall in September, 1884.

The International Electrical Exhibition was held in West Philadelphia, at Lancaster Avenue, between Thirty-second and Thirty-third Streets, occupying a lot having an area of 66,650 square feet. In addition to this a bridge connected a large additional area formerly occupied by the Pennsylvania Railroad Company and its West Philadelphia passenger station.

The exhibition opened on the 11th of August and closed on the 11th of October, 1884. An admittance fee of 50 cents was charged, school children being admitted at reduced rates, and the number of admissions was 282,779. The total receipts from entrance fees was $98,637.70. The total horse-power required for exhibiting the machinery and the lighting of the exhibition and buildings was 1800.

The exhibits embraced a large variety of electric apparatus both from the United States and Europe. Indeed, in so far as variety is concerned in electric apparatus and machinery, the exhibition of 1884 would compare favorably with that of the Chicago World's Fair, to say nothing of the present New York Exhibition, but it must be remembered that times have changed materially since that date, for at the time of the Chicago Exhibition many of the exhibits which proved interesting from their novelty at the Philadelphia Exhibition had already so taken their place among the actual necessities of our modern life that they would no longer be regarded as suitable for display. There were 270 exhibitors, and among those which attracted the most attention was the electric fountain occupying approximately the centre of the main exhibition hall. The Edison speaking phonograph was another great novelty, while probably the most attractive feature was a pyramid of incandescent lamps 30 feet high and six feet wide at the base, containing 1200 separate incandescent lamps. Owing to the power required to light these lamps they were lit only at certain hours of the day.

A mimic waterfall, in which the water was supplied by an electrically driven pump, also occupied considerable attention. Exhibited by the side of the speaking phonograph were other pieces of apparatus by the same eminent inventor, comprising a musical telephone, a chemical recording telegraph and an electrical motograph.

To the general public who found it impossible to understand how two telegraphic messages could be simultaneously sent in the same direction on the same wire, the working exhibit of a harmonic multiplex telegraph where 12 such messages were sent caused much astonishment, but on stepping across the aisle to an exhibit of synchronous multiplex telegraphy, where 36 messages were simultaneously sent in one direction over a wire, while 36 were being sent in the opposite direction at the same time, they were completely bewildered, and gave up all hope of understanding it.

The United States Government took considerable interest in the exhibition, and had a fine display of electrically operated apparatus. The departments of the Government exhibiting were the following: The Ordnance Department, the Coast and Geodetic Survey, the Signal Office, Patent Office and the Smithsonian Institution. Among some of the exhibits of the Ordnance Department may be mentioned a torpedo boat, testing and firing apparatus for ships' guns and torpedoes, torpedo spars, electric fuses and igniters, magneto-electric circuit-closers, etc.

Among apparatus exhibited by the Coast and Geodetic Survey were electric chronographs, automatic transit recorders for the determination of personal equation, various chronoscopes and chronographs, velocimeters and direct-circuit chronometers. The United States Signal Office exhibited a variety of apparatus employed by the Weather Bureau. The Smithsonian Institution made some valuable historical exhibits, including Morse's first telegraphic instrument. The United States Patent Office exhibited about 200 models, including dynamoelectric machines, arc lamps, etc.

The foreign exhibitors were well represented, and included the most celebrated houses of Europe. Among some of the more interesting was a large Ruhmkorff coil giving a spark 20 inches in length, secondary batteries of various kinds, and Jablochkoff candles.

It is an interesting fact that in the Exhibition of 1884, there was an unusually large and full display of the various Geissler and Crookes tubes. A feature of the exhibit was a mercury pump employed in exhausting these tubes, sent by Dr. Geissler direct from his laboratory.

In sharp contrast with the telephone exchanges of to-day, some of which can show 5000 subscribers, was an exhibit much admired at the time, of an exchange capable of handling 25 subscribers.

Among the educational features of the exhibition, apart from the historical collection, may be mentioned a library which formed a nucleus of the Franklin Institute's present Memorial Library of Electrical Science. Another educational feature of the exhibition was a series of lectures delivered by well-known scientific men. Among these may be mentioned a lecture by Prof. George Forbes, on "Dynamoelectric Machinery," and by Sir William Thomson, now Lord Kelvin, upon the wave-theory of light.

It reflects no little credit on the management of the Franklin Institute that they selected the time for holding the exhibition when so many scientific men from abroad were present in Philadelphia, for the exhibition was coincident with the meeting of the American and the British Associations for the Advancement of Science.

The Historical Importance of the Frankfort Exposition.

BY WALTER LOBACH.

Among the many electrical expositions which have been held since electricity has developed from its small germs in the laboratories into a great industry, none has proved of more significant importance in the history of the art than that held in Frankfort-on-the-Main, in 1891. This is owing to the fact that it was created from a pressing demand to show the public the striking results of rapid and healthy progress, especially in its bearing to the generation of light and power; in the use of large currents, inaugurated by the invention of the incandescent lamp and its exhibition in Paris in 1881. From that time electricians were busy at work to overcome the technical difficulties of distributing currents from central stations over large areas, and efforts reached their greatest triumph by the erection of the central stations at Berlin. The technical perfection and the financial success of these works stirred up the attention of a great number of other cities desirous of being furnished in the same way with this new method of lighting, and, as a consequence, manufacturers were overtaxed in order to satisfy the demand for new plants and projects. The continuous-current system had been thus far the basis on which not only nearly all of the smaller but also the larger stations were erected. But the introduction of the transformer and its recognized advantages for distributing currents more economically over larger areas was beginning already to turn the attention of electricians as well as city governments to the merits of alternating-current systems. The City of Frankfort, one of the weathiest in Germany, intended to introduce apparatus of the very best, and as the question arose which of the two systems known up to that time would be the better to supply light and power to the city, a commission of experts was appointed in 1889, and the leading firms of the world were called into competition. After much careful study and elaborate reports, no final decision was arrived at either in favor of the continuous or alternating-current system. The latter, however, was recommended as preferable, although the question of reliable transmission of power was practically left open. The city authorities not satisfied with the result of expert testimony decided upon an international electrical exposition, and the manufacturers of the world were invited to exhibit. In 1891 the great Exposition was opened to the public, and the most prominent question put forth was that of relative advantages of alternating and continuous currents. All the large and small concerns of Germany and a few from other countries were active in showing the finest displays and the enormous advances which had been made in central-station work. Whole central station plants of thousands of horse-power were erected in the machinery hall. The largest of direct-connected units revolved for the first time in history with their gigantic armatures before the eyes of an astonished public. But all of this power and the thousands of incandescent and arc lights were not destined to bring about the solution of the great question, to which the City of Frankfort, and with her the world, was awaiting an answer. There could not be found among all the numerous exhibits the solution of the problem, the greatest drawback to the alternating-current system, namely, the satisfactory working of motors, and yet this solution was really to be shown for the first time upon the largest scale ever attempted. The polyphase-current system, the new born Hercules child of the electrical art, was destined to receive its real baptism in the waters at Lauffen. The three-phase current system, based on the principles of Ferraris's early experiments, was worked out to such a state of perfection that it justified the courageous idea of electrically transmitting an amount of 300 horse-power over a distance of 110 miles. By a fortunate combination of circumstances the water-power at Lauffen, and even the primary dynamos were on hand, but not without the hardest struggle could the transformers and other apparatus have been put in operation had not the government agreed to construct the overhead line. Only the greatest efforts and a knowledge of the vast importance of carrying out successfully this project could have led to its reality and justified the expenditure of nearly one half a million marks for an experiment of but a few weeks' duration. The success of the Lauffen-Frankfort transmission with its total efficiency of 75 per cent. and its highest voltage of 31,000 volts are known to the world and needs no further comment. It is very characteristic that after the exposition, the whole fight between alternating and continuous current advocates seemed to be ended, and that each was obliged to be contented with the field for which each was best fitted by its peculiar qualities. It is interesting to remember that the desire to obtain the best methods for distributing light in the City of Frankfort having demand for but about 25,000 incandescent lamps, led to the carrying out of this historical exposition. The enormous progress which has been made since in polyphase transmission work, the erection of the Niagara plant and many others cannot fail to remind us of the words of Helmholtz when closing the Frankfort Exposition: "The experiment seems to be successful. Remote water-powers have been made useful. The beginning is done. This is a remarkable event of extraordinary importance from the point of political economy, and therefore the Frankfort Exposition has proved indeed a very great success which will develop its fruitfulness only in the coming years."

The Antwerp International Exposition of 1894.

The Antwerp International Exposition of 1894 being located in the most attractive city of Belgium was sure to be visited by many foreigners. Antwerp, which is now the principal seaport of Belgium and one of the most strongly fortified cities of Europe, was formerly one of the most wealthy and prosperous on the continent. Its commerce in the fifteenth century extended over the whole civilized world and at that time fairs were frequently held which attracted the merchants from all quarters of the globe. The exposition of 1894 may be considered as a revival of the old world's fairs which had attracted so many merchants to the markets of Antwerp, and in fact, the plan of this exposition was primarily commercial.

The principal exposition buildings covered about 25 acres and were tastefully located in a small park in such a way as to secure the maximum benefit of the limited area. At the larger expositions of Paris and Chicago there had been no charge for floor space, but at Antwerp the exhibitors paid from $1 to $2 per square foot for the space occupied, in addition to a percentage of the money received in sales made at the exposition. Most of the exhibits were either from Germany, France or England, the number of American exhibitors

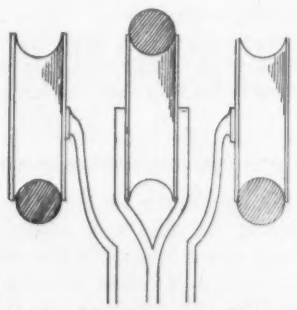
being very small. The electrical exhibits were good, but with two exceptions they were neither novel nor of special interest. The Compagnie Internationale d'Electricité of Liege, which had the concession for lighting the grounds, exhibited some very large machines in operation. Four dynamos for arc lighting were each of 80-kw capacity at 500 volts, and in another space a four-pole compound-wound generator on the same base and directly connected to a compound Willans engine of 100 horse-power and 460 revolutions, was shown in operation. The generator had a capacity of 500 amperes at 120 volts. The total amount of electricity generated at the exposition was less than 450 kilowatts.

Among other exhibitors were the Societé Anonyme Electricité et Hydraulique, which made an attractive exhibit ; the Bell Telephone Company, the Antwerp Telephone & Electrical Works, the Societé des Arcieres de Charleroie and the Societé Anonyme de Marinelle et Coullet.

A striking feature of the exposition, especially to Americans, was the display of direct-connected dynamos to gas or petroleum engines. Expensive exhibits of this kind were made by both a prominent Belgian and a German maker. The variety was not as great as that exhibited at the Crystal Palace Exposition in 1892, but consisted perhaps of larger machines in operation, some being of as much as 200 horse-power.

In the French section centrifrugal pumps directly connected to electric motors were exhibited, and in the British, simplex and other telephones of the Ander Telephone Company. Schuckert & Co. displayed their searchlights for the Belgian army, one of which, located near the museum, was said to have been visible for a distance of 40 miles from Antwerp. It has a projector with horizontal carbons and consumed 150 amperes at 65 volts.

The electrical feature of the exposition which attracted most attention and a great deal of discussion was the trolley balloon, and it needs to be considered, not on account of its success, but because of its failure. For many years it has been thought that electricity would finally be the energy used in the propulsion and management of the successful dirigible balloon whenever such should be invented Some have advocated the use of storage batteries on the car, but these have, up to the present, proved too heavy. Others have thought that a successful system would use the trolley. The Antwerp exposition offered a favorable opportunity for such a test, and a trolley line of about one mile in length was constructed between the centre of the city and the exposition. This line consisted of three one-inch steel cables suspended from six steel trestles, which were placed about 1000 feet apart. These trestles were shaped like an inverted V with one leg on each curb and the apex over the middle of the street. The trestles were about 100 feet high. The idea of using three cables seems to have been that a triphase current would be the best for the work, and also that three cables could be so placed that an easily moving trolley could be used. The trolley consisted of six contact wheels in pairs, the pairs being in parallel planes. The cables were placed as shown in the diagram and a pair



Arrangement of Trolleys.

of wheels made contact with each cable. The balloon selected was an elongated shape and was made of two layers of linen with three coats of varnish between. The length of the envelope was 267 feet, and the length over all 284 feet; its greatest diameter was 57½ feet; its height over all 70 feet, and its capacity 594,400 cubic feet. When filled with a gas having a specific gravity of .35 this balloon would have an ascensional force of 24,200 pounds at a temperature of 60 degrees Fahr., 23,400 at 72 degrees Fahr., and 21,320 at 100 degrees Fahr. As the weight of the balloon and a load of 35 passengers was calculated to be about 19,000 pounds, it will be seen that the balloon was apparently sufficiently large. At 100 degrees Fahr. it was necessary to inflate the balloon to 89 per cent. of its capacity, while at 72 degrees it was only necessary to reach 80 per cent. At these percentages of inflation the balloon could rise 5700 feet at 72 degrees Fahr., and 3300 at 100 degrees before the envelope would be full of gas at the reduced pressure. As it was intended to run the balloon at a height of 500 feet it will be seen that it was at least as large as was necessary to carry the proposed load. The trolley was connected by a flexible cable 500 feet long to an Oerlikon motor in the car of the balloon. This motor, which was rated at 125 horse-power, used current at 350 volts and worked at a speed of 1550 revolutions per minute. The frequency was 54 periods per second. The shaft of the motor was geared to a propeller shaft, which in turn was geared so as to run at a speed of 113 revolutions per minute. The propeller had four blades and was 26¼ feet in diameter. The machinery had been designed to produce a velocity of about 25 miles per hour in a calm. In an ordinary breeze of 15 miles an hour, if head on, the speed would not exceed 10 miles an hour. A beam wind of this velocity would cause the connecting cable to pull the trolley with a force of at least 3750 pounds. On many other directions between the beam and the head wind this cross pole would be altogether too large. This, together with the impossibility of properly steering the balloon, are the causes for the failure of the experiment. It would have been better perhaps to have placed the motor and a grip upon the cables, and to have towed the balloon in that way. Aside from their use in military operations it does not seem that there can be any great demand for such balloons. When used for passenger conveyances they must have a displacement of at least 6000 cubic feet for each passenger. This necessitates a large cross-section or a large exposed surface. Either implies large power. The Antwerp balloon was designed to use 125 horse-power and 13,700 pounds of conveyance to accomplish what is easily done on street railways with 15 horse-power and 8000 pounds of conveyance.

Central-Station Working—XVI.

The Worcester (Mass.) Electric Light Station.

The Worcester Electric Light Company's station affords an interesting example of the development of a lighting and power station, employing the Corliss type of engine belted to shafting and operating generators through the intervention of friction clutches, when intentionally designed on that basis and with that form of power transmission kept deliberately in view in providing for future expansion.

After having outgrown its previous quarters, the present building and its interior arrangements were planned and erected in 1890 with the intention of anticipating as far as possible future requirements, and therefore largely in excess of the needs of the moment. The wisdom of liberal expenditure and first-class construction is shown by the fact that the company is and has been paying a dividend of 8 per cent., an unusual showing in these times, except for very large plants in cities of the first rank.

In describing the extension of the plant, and the growth of its output, we will first give a brief account of the station as originally designed and erected, and then show its subsequent expansion.

The main building, containing the dynamo room, 200 x 75 feet, with two parallel lines of shafting in the basement below and offices. storerooms and the like above, is a substantial brick building of the modern mill type of construction with a truss roof, in the rear of which are, successively, the engine room, 94 x 42 feet (now 112 x 42 feet), and boiler room 150 x 46 feet. Commencing with the boiler room we find two batteries of boilers, four in each, (made by William Allen & Sons, of Worcester), being 6 feet in diameter by 18 feet 3 inches long, and having each 124 three-inch tubes 17 feet in length, the boilers being of the horizontal multi-tubular type. The feed-water heater, a "Victor," furnished by the same firm, is intended for live steam. and has a rated capacity for 1200 horse-power.

Two No. 6½ Knowles pumps are in operation, either one being sufficient for the entire work, in addition to which are two "Parke" injectors rated at 800 horse-power each. The two engines first installed, rated at 500 and 300 horse-power respectively, are of the cross-compound condensing type, and were built by the Corliss Steam Engine Company, of Providence, R. I. The cylinders of the larger one are 22 inches by 48 inches and 40 inches by 48 inches, the steam pressure used being at 125 pounds; the fly-wheel weighs 42,000 pounds, runs at 70 r. p. m., and is 22 feet diameter by 52 inches face. In the smaller engine the cylinders are 18 inches by 48 inches and 32 inches by 48 inches; the fly-wheel weighs 35,000 pounds, has the same

rotative speed as the larger one, with a diameter of 20 feet and 38 inches face. These two engines are provided with jet condensers (an ample and permanent supply of water for condensing purposes being available), and the air-pumps are respectively 12 inches stroke by 30 inches bore, and 12 inches stroke by 26 inches bore. Space was allowed in the engine room for two additional engines of substantially similar dimensions, and an extension was ultimately found necessary to be made, for the engine last set up, to be referred to hereafter.

Referring now to the method of distribution of power to the

SWITCHBOARD.

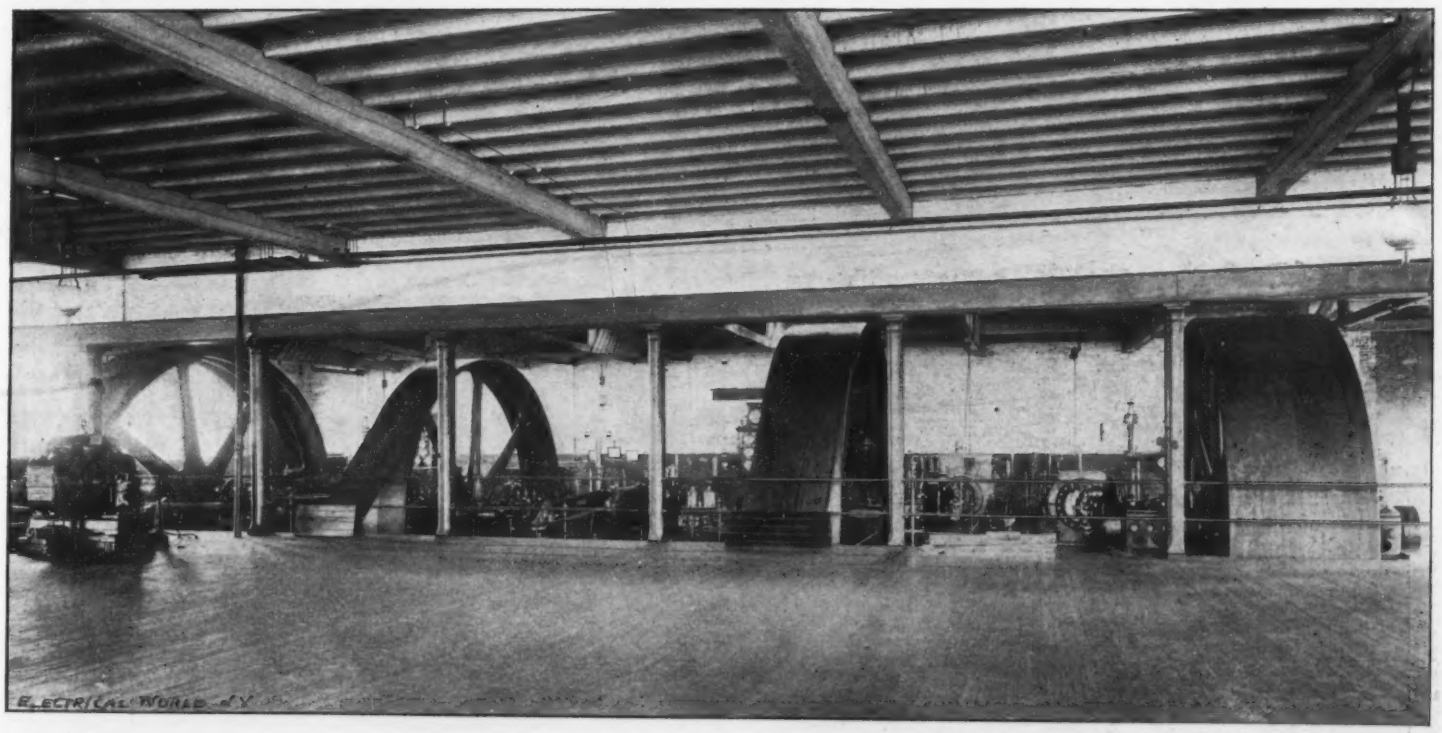
various machines, it will be remembered that the much vexed questions of large *vs.* small power units, direct-belted engines, high and low rotative speeds, and the like, have really resolved themselves for the most part into the simple question of adaptation of units to load, so that all power units may, so far as possible, be always employed at their maximum load and maximum efficiency, and also avoid excessive friction losses in operating long lines of shafting for light loads. The manner in which the most economical and efficient arrangement of shafting has been attained in the Worcester plant is as follows: The two engines first described are belted over idlers or belt tighteners to two main driving pulleys on a 6-inch steel line shaft, running at about 275 revolutions per minute (one line of shafting only being utilized in the first instance), and from friction clutch pulleys on this shaft belts run up through the dynamo floor to the pulleys of the various machines. Strictly, however, these main driving pulleys are not on the shaft, but run on a "quill" having independent bearings, and through which the shaft passes freely, so that either engine can be started up without operating the shaft itself until connected by a clutch. The shaft is also divided into five sections by friction-clutch couplings, so that it will be seen that either engine can operate either half of the shaft, or both can operate together on heavy load, and this with a minimum of useless shafting, with its consequent friction. A friction-clutch pulley on each shaft and connecting belt enables either line of shafting to be operated from the other. Both lines can thus be run by either one, two, three or four engines, according to load and requirements, or any section, by any engine, the new or second line of shafting being normally adapted to be run by the new engines.

The dynamo room itself, 200 feet long by 75 feet wide and 14 feet high, is entirely clear and unobstructed by pillars, the ceiling being suspended from the roof trusses. In the centre of the room, beneath a wire tower, 48 x 14 feet, are the various switchboards, the leads from the various dynamos being carried to them under the floor of the dynamo room. This floor is of 2 x 4 feet spruce set edgewise and a surfacing of 1⅛ inch maple, resting on 12 x 14 inch timbers of Southern pine supported by brick piers, making a very rigid construction.

The original dynamo equipment consisted of 18 T.-H. arc light machines, mostly 30 lighters, giving a capacity of some 560 lights, and two alternators, one a 1300-light and one a 650-light machine. The switchboard for the arc lights which has not been increased in capacity since its erection, is arranged for 24 circuits, and is of the Thomson-Houston plug type (the first one, we believe, installed by them) while the alternating skeleton board was a two-machine two-circuit board. No power service was originally provided for.

Coming now to the extensions, the arc light capacity is now some 990 lights, the dynamos being 15 50-light and 8 30-light T.-H. machines; there are also 4 A120-alternators of the same make, having a capacity of some 8000 lamps, 13,000 being actually wired up. For the 500-volt power circuits the dynamo equipment consists of two M. P. G. E-100 and one M. P. G. E-200 machines, or something over 500 horse-power. There are about 400 horse-power in motors installed, in sizes ranging from ½ to 30 horse-power.

For the alternating service there is now a skeleton structure carrying the various instruments, switches, etc., for four dynamos and a four circuit safety board for transferring dynamos and circuits. Thomson recording wattmeters are also placed in the primary circuits, thus enabling the station output to be compared with the readings of the consumers' meters, and any abnormal loss is noted and remedied.



ENGINE ROOM OF WORCESTER ELECTRIC LIGHT STATION.

The power circuit switchboard is of the latest General Electric Company's slate panel type, and consists of two dynamo-panels and a two-circuit feeder-panel, completely equipped with voltmeters, ammeters, circuit-breakers, etc.

With regard to the increased power necessary for this increased dy-

namo capacity, the third engine was installed in the year 1892. It is of 600-hp rating, and its cylinders are 22 x 48 inches and 44 x 48 inches; the fly-wheel runs 70 revolutions per minute, is 22 feet diameter by 62 inches face, and weighs 56,000 pounds. This engine is also cross-compound condensing, with air pump. The successive demands upon the plant rendered even the conjoint capacity of the three engines insufficient, and a fourth engine of 800 horse-power is now in course of erection. It is of the same type and manufacture as the others, and will run at the same speed; for condensation purposes, however, a Knowles spiral-condenser is used. The cylinders are 26 x 48 inches and 48 x 48 inches, the fly-wheel (double-spoked) 22 feet x 68 inches, and weighs 65,000 pounds.

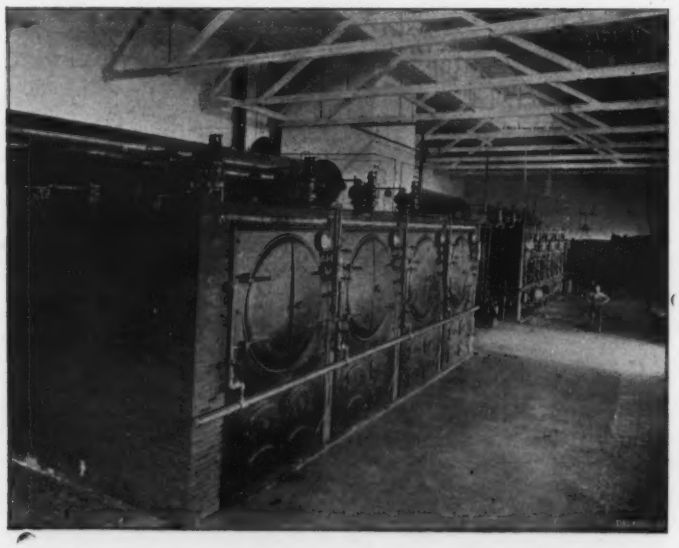
The two newer engines are belted to the new line shaft in a

Dynamo Room, Worcester Electric Light Station.

similar manner to that employed in the case of the original installation, so that the whole system of shafting may now be regarded as complete, with the exception that, should the occasion arise, subsidiary lines might be run off these two main lines. The shafting, clutches, and so forth were erected by the Holyoke Machine Company and the dynamo and engine belts by the Graton & Knight Company. The steam and vacuum gauges are made by the Star Brass Manufacturing Company, and are of handsome appearance, mounted on a black walnut board.

It will be observed, therefore, that in the past six years the output of the station has increased in capacity from 550 arc lights to 900, from some 2000 incandescent lights on the alternating system to 13,000, and in power service from nothing to over 500 horse-power, and this without any structural alterations other than moving one end of the engine room a few feet.

The company has an enviable record in other directions, having never had an accident and never had a "shut-down." This result



Boiler Room, Worcester Electric Light Station.

Mr. W. H. Coughlin, the superintendent, modestly ascribes to "good luck."

The general arrangement and condition of the plant reflect great credit on Mr. Fairbanks, the treasurer, and Mr. Coughlin. When the period arrives for increasing the present capacity of the station the company owns sufficient land for large extensions, and for some classes of work direct-connected units may be employed.

In conclusion, a word as to the underground work being carried out by this company, which took the initiative in applying to the city for permission to construct conduits and so forth at their own expense. They have thus far laid some 200,000 feet of duct, extending through two miles of streets. The system used is that of the National Conduit Manufacturing Company, employing cement-lined wrought-iron pipe laid in concrete. From the station 36 three-inch ducts are laid to the central portion of the city, and thence lead to the various streets in the business district, it not being the intention to extend the system to the suburbs at present. Although the cables have not as yet been drawn in, this work will be commenced very shortly.

It would be premature to give any details of the method of connection with the underground service or local distribution, as these matters are still undecided. It may be said, however, that the methods will probably resemble those adopted in Boston (see "Underground Wires in Boston," Electrical World, July 20, 1895), but modified to suit local conditions.

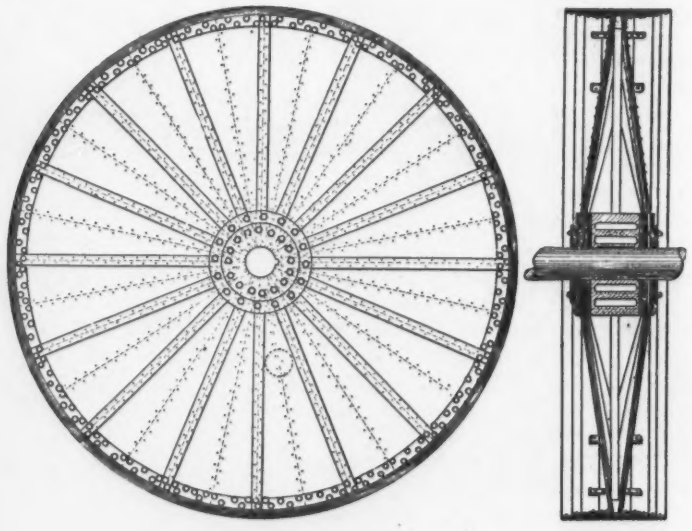
A number of overhead circuits will be retained for the residential and suburban districts, the whole of the outside construction work being of a substantial character. Washburn & Moen wire is used for this purpose, and a special form of arc light suspension employed, consisting of a light lattice girder truss across the street from which the lamp hangs, made by the Worcester firm of C. W. Walls & Son. Space however prevents our entering further into details at the present time.

The financial condition of the company also appears to be very satisfactory, although the total liabilities are only $301,000 (stock, bonds and unpaid bills) yet the assessed valuation for taxes exceeds $250,000 and at the end of the last fiscal year, after paying 8 per cent. on its capital stock, 5 per cent. on the bonds and allowing some $38,000 for depreciation, a profit and loss balance was carried forward of over $47,000.

Structural Steel Fly-Wheels.*

BY THOMAS E. MURRAY.

With the increasing use of large and fast-running engines in the generation of electric power, the problem of providing fly-wheels which shall not be liable to bursting is one of great and growing importance to the mechanical engineer. This is especially so because large power stations are usually and necessarily located in the central and crowded sections of cities, where any accident is liable to cause much loss of life and the destruction of much valuable property. That large iron castings are unreliable, when subjected to sudden and severe strains, is recognized by all. It is evident that cast-iron fly-wheels have reached the limit of development,



Structural Steel Fly-Wheel.

and it is doubtful if much further improvement is to be expected in them. The frequent accidents to large wheels of this type show that there must be some radical change in construction, in order to

* Paper presented at the St. Louis meeting (May, 1896) of the American Society of Mechanical Engineers.

make wheels which shall be free from danger of bursting by centrifugal force.

With the cheaper production of steel, the latter metal, in nearly every branch of mechanical industry, has taken the place of cast iron, and the object of this paper is to describe a novel application of steel plates as a substitute for cast iron in fly-wheels.

The engine for which this new wheel was designed and made was one of a pair in the power house of the Albany Railway at Albany, N. Y.

The former cast-iron wheel which it replaced and which was 20 feet in diameter by 50 inches face, and weighing 50,000 pounds, burst, causing considerable damage. It was connected to a 20-inch by 36-inch by 48-inch tandem-compound engine, and was belted to a 48-inch pulley located on a 500-kw generator.

Running under normal conditions this engine made 72 revolutions per minute. At the time of the accident, the speed of the engine (according to statements given at the time, and from computations made from the distances that portion of the wheel was thrown) was far beyond the conditions of everyday practice.

The author does not attempt to state here the cause of the accident, or the acceleration in speed, but his faith in *cast-iron fly-wheels* was considerably shaken, and to replace the broken wheel he naturally looked for something better and of different material, which would stand the very high rate of speed and have a greater factor of safety, and, at the same time, locate the weight in the wheel where the best results would be accomplished.

The steel was of a grade known as "shell-steel," *open hearth* process, and of 60,000 pounds tensile strength, and great care was used to have grain in the direction in which the plates were rolled, placed in position so as to give the greatest strength. All rivets used were Burden's best, and were of two sizes, namely, 1¼ inches, and ¾-inch in diameter.

The hub is described as follows: Six ¾-inch discs were sheared 36 inches in diameter, and fourteen 48 inches in diameter, and these plates together with the cast-iron separator or spider 23 inches long by 48 inches in diameter composed the hub, and were assembled as follows: Two sets, composed of three 36-inch and three 48-inch discs each, were drilled for thirty-two countersunk rivets, and after being securely clamped to tight joints, were riveted together, making two hub sections for outer part of wheel hub, each 4½ inches thick, and these were bored to a "driving fit" to shaft; two sets of four discs each were secured together and bored in same manner for inside sections of hub, giving a steel bearing on shaft of 15 inches. The casting or spider, weighing 2700 pounds, was bored to a close fit and placed on shaft. This casting was faced on ends and cored for thirty-two 1⅛-inch hub bolts and provision made for keys. The four steel hub sections were next clamped together and bored for the thirty-two steel bolts. The two sections, 48 inches by 3 inches, were driven on the shaft, one against each end of spider, and one of the 36-inch by 48-inch by 4½-inch started on each end of shaft and driven past bearings, after which the shaft was set in position in bearing. Each part of hub was faced to right angles with bore.

Two dished webs were formed 19 feet 6¾ inches in diameter, each composed of two layers of ¼-inch plate, and each layer having 16 sections, making 64 plates in all. These plates were drilled so as to have all joints broken. Said rivet holes were 3 inches on centres, staggered, and 4 lines of holes running lengthways of plate. The small ends of plates were heated and bent on a form to right angle to shaft, and each drilled for two 1⅛ hub bolts. The rim ends of plates were drilled for 2 lines of rivets, and in such a manner as to properly secure segments of 6-inch by 6-inch by ½-inch angle irons. These plates were next connected between inside and outside hub steel plates, sections forming 2 complete dished discs which were 2 inches apart at rim, and 29 inches apart at hub. Thirty-two 5-inch by ¾-inch steel bars were fitted one over each outside joint of disc plates with hub end bent, and rim ends formed two right angles with centre of wheel or parallel with shaft. This end was bent to secure rim in connection with angles, and were each drilled for 2 1¼-inch rivets. Great care was used in making these bends, and sharp angles were avoided. All bars were drilled from a template. After the bars and plates were assembled in position, with temporary bolts, the hub was bolted together with bolts passing entirely through hub and discs and drawn close and firmly together, each bolt passing through 2 bars, 4 plates, and all parts of hub. Between the outer edges of discs a cast-iron filler ring was placed and all bolted temporarily together. As all parts were drilled to templates, the work proved true and in line. The riveting was done from the outside, with one man inside holding on and taking the hot rivets through a man-hole left for that purpose.

RIM.—The manner of constructing rim was as follows: eight 32-inch by ½-inch plates were rolled to form a circle, and riveted to, and with joints over the 5-inch by ¾-inch bars. Over these plates another layer of 40-inch by ⅝-inch plates, in 16 parts, was placed with joints broken over the first layer. The 6-inch by 6-inch by ½-inch angle iron was next formed, and securely riveted and bolted to discs, and also through both rim plates, with countersunk rivets. The ⅝-inch by ½-inch plates were also riveted together, rivets 4-inch centres. Another layer of ⅜-inch plate, 50 inches wide, was next riveted on. This was also cold rolled, and the last or face sheet, 50-inch by ⅞-inch, was rolled hot and riveted on. The countersink of last sheet was almost its full thickness; 64 1¼-inch rivets were driven through the 5-inch by ¾-inch bars, and all rim plates connecting all plates and discs. The wheel was then keyed to shaft with two cast-steel keys, one driven from each side of hub, and without turning or facing the wheel in any way, the belt was put on and the wheel put to work. The belt remained in centre of wheel, and has been running two months. There are three points in the diameter of wheel which buckles in plate, due to heating, raised ⅛ of an inch out of true, but the balance of wheel is practically true and in line with shaft. The wheel will be turned later. The weight of wheel is 57,930 pounds, distributed as follows: rim, 32,000; discs, 16,400; hub, 9530.

In calculating the strength of this wheel we need not begin at the hub and figure out every part as in a cast-iron arm-wheel. It is enough to know its strength at the weakest point, which is undoubtedly the outer layer of rim plates, as those plates must leave the wheel before any other part could give way.

Each of these plates weighs 590 pounds, and the direct centrifugal force on each plate, tending to hurl it off the wheel, is, according to Haswell's formula:

$$F = W\frac{n^2 d}{5217} = \frac{590 \times 72^2 \times 20}{5217} = 11{,}725 \text{ pounds nearly.}$$

But these plates are held in position by rivets having a total area of 20.75 square inches, which at a strain of 15,000 pounds per square inch would carry 311,250 pounds.

$$\text{Then the factor of safety } \frac{11{,}726}{311{,}250} = 26 \text{ nely.}$$

I regard the device of making the discs or webs dished on the same principle as a bicycle wheel, as the most important feature of this wheel, and I believe it could be applied with success to broad-faced wheels for mill work by using double pairs of discs, and also to balance wheels, such as are used with direct connected engine for the generation of electric light or power.

The Reconstruction of the Plant of the Chicago Board of Trade.

(*Continued from page 647.*)

It will be evident that the 15 end cells, or at any rate a portion of them when working in this manner, will become discharged through the day's run. After the batteries are cut off from the light, these end cells are re-charged as follows: Switch No. 23 is closed, thus throwing in the booster motor. As soon as the booster dynamo is brought up to speed, the underload switch is closed, and switch No. 22 closed upward, the operation then being as follows: From the positive brush of the generator end of the booster, which is producing energy at a low voltage, the current passes through the proper conductor to the centre of the automatic regulator; thence out through the regulator arm onto segment No. 1, and through proper connection to cell No. 1; thence through the first 15 cells to the wire leading off between the fifteenth and sixteenth cell. From this point it passes along the conductor, through switch No. 23 to the underload switch, and from the underload switch back to the negative side of the booster generator. By means of a field rheostat, located on the switchboard, the E. M. F. of the booster generator is regulated and adjusted to correspond to the number of end cells which are being charged.

To charge all the cells in series from one of the main generators, it is necessary to increase the E. M. F. a sufficient amount to overcome the total voltage of the cells. This is done by placing the generator portion of the booster or motor-generator in series with the main generator as follows: Switch No. 23 is closed, thus throwing in the booster motor and at the same time energizing the fields of the

booster dynamo. The booster motor is now started by means of its rheostat and brought up to speed. Switch No. 22 is closed downward, the path of the current then being as follows: From positive lighting bus-bar through switch 22, to the underload switch, thence to the negative brush of the booster dynamo, out through the positive brush to centre of the automatic regulator, through this arm to segment No. 1, and thence through suitable connection to cell No. 1; through the entire series of cells to the negative lead, thence through the recording ammeter and overload switch; back through switch 22 to the negative lighting bus-bar. The operations for manipulating the entire plant being then as follows:

To charge all the cells in series with the main generator by means of the booster: Open switches 16 and 17 and close switches 23 and 22 down.

To charge all the batteries, except the end cells, at the same time operate light and elevators from one dynamo Place hand regulator on segment 16, connect whatever dynamo is in use to elevator bus-bar by means of its elevator switch, either 11, 13 or 15, in the *b* position. Disconnect dynamo from lighting bus-bars by opening its corresponding switch, either 10, 12 or 14, and see that switches 22 and 23 are open, and that switches 16 and 17 are closed, the latter in the *a* position.

To charge end cells with booster dynamo: Place automatic regulator on segment No. 1, see that switch No. 16 is open, and close switches 23 and 22 up.

To place elevators, batteries and one of the generators in parallel, close the corresponding generator switch to the *b* position, and close switch 17 to the *a* position, if desired to run through the hand regulator, and to the *b* position if desired to operate through the automatic, but if placed in the *b* position, see that switch 16 is open.

To discharge the batteries with the generators shut down, operate as follows: On lights, open switches No. 22 and 23, and close switch 16. On elevators, close switch 17 to the *a* position. To operate lights and elevators, see that switches No. 22 and 23 are open, and close switches 16 and 17, the latter to the *b* position.

Fig. 4 shows the elevation of this switchboard, and from it the position of the instruments shown on the diagram can be easily located

The method of connecting the engines and generators is shown in Fig. 5, and represent a system planned by the writer, which enables a direct-coupled plant to be so built as to have the advantage of an independent unit when operating under normal conditions, and all the flexibility of a belted plant in case of accident to any particular part of the plant. The cut shows the plan, elevation and section. It will be noticed that at present there are but two generators and two engines; but when extensions are needed, the right-hand engine will be disconnected from its present dynamo, and moved to the right a sufficient distance to allow the placing of an engine of double its capacity in the same position it now occupies, and two generators between the middle engine, and the right-hand engine, thus making a plant with three engine units and four generator units, all four of which are available from the middle engine, and two of which are available from each of the outside engines. Referring to the sectional view, *A a* represents the ends of the engine shafts which carry discs *H h*. The generators are mounted upon hollow sleeves or quills, which are supported in independent bearings, *P P* and *p p*. The ends of these quills are enlarged to form flanges corresponding in diameter and thickness to the engine flanges. Between the engine shafts, *A a*, extends an auxiliary shaft, *E* (coupled at its centre, in this case, to permit half of the plant being put in operation before the other half is ready), and carried in independent bearings, *D d*. This shaft, *E*, carries at each end circular discs, which in this case are forged solid with the shaft. Under normal conditions shaft *E* does not revolve, but lies passive in bearings *D d*, and the engines drive the generators direct coupled, by inserting the bolts *U u*, three of which, spaced 120 degrees apart, are used in each coupling. It is now evident that each engine is operating an independent direct coupled generator without revolving any more shafting or machinery than is usual in ordinary independent direct-coupled plants, inasmuch as the quills which surround the auxiliary shaft, *E*, do not come in contact with it, but have a clearance of one quarter of an inch all around it. If from any cause it becomes desirable to drive the left-hand generator from the right-hand engine, it is done as follows: In the openings, *v*, three of which are provided 120 degrees apart, are placed taper bolts which couple the auxiliary shaft, *E*, solidly on the engine shaft, *a*, by means of disc, *h*. Taper bolts are also placed in spaces, *W*, which couples shaft, *E*, to the quill of the left-hand generator. By removing bolts, *U*, which disconnect the left-hand generator from the left-hand engine, the left-hand generator can now be driven from the right-hand engine, and the right-hand generator continues in operation from the same engine, if desired. By removing *u*, the right-hand generator becomes disconnected from the right-hand engine, and the left-hand generator is being driven from the right-hand engine. In the same manner the right-hand generator can be driven from the left-hand engine, or both generators from either one of the engines. By using compound engines, so designed that by working high-pressure steam in the low-pressure cylinder, one engine can be made to double its power for a few hours. The plant has thus the total generator capacity available at all times, and allows one engine to be in reserve for repairs, thus doing away with the investment of the third unit, which is usually carried in such plants for safety. The system, when used without the battery auxiliary, instead of being provided with bolted connections as here

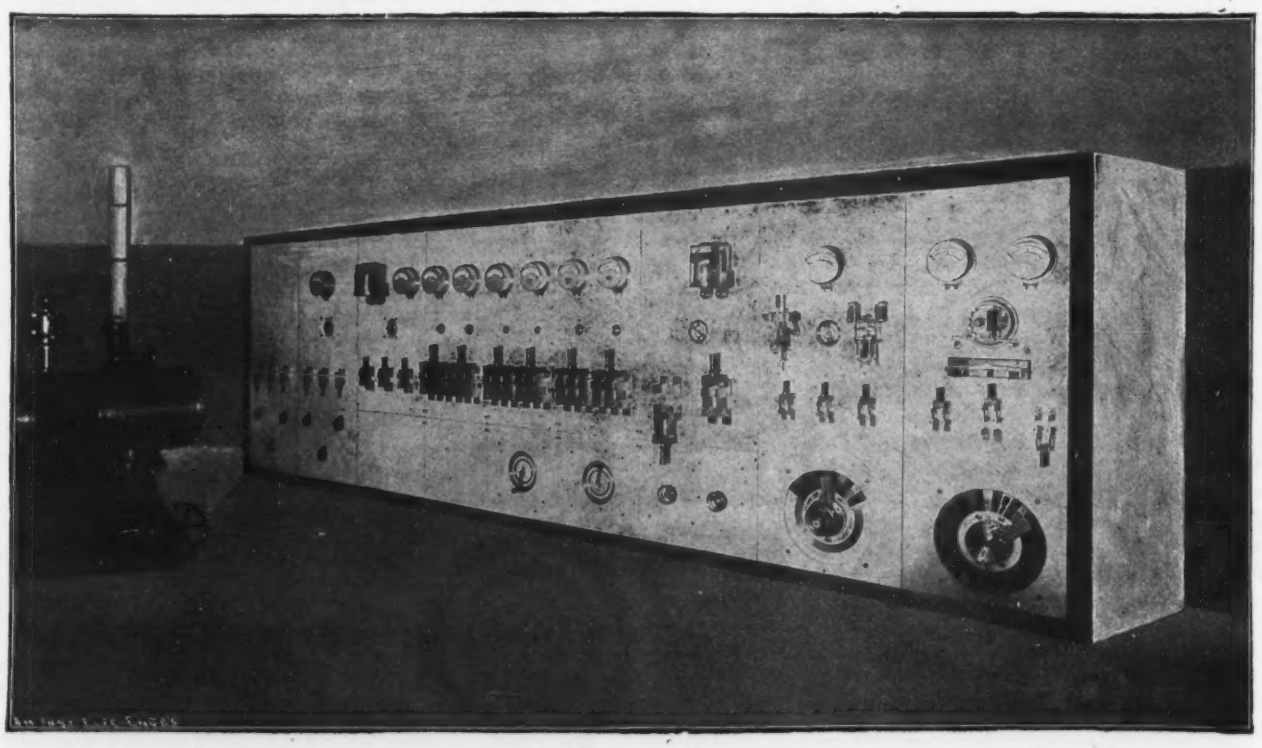


Fig. 4.—Switchboard.

shown, is provided with magnetic clutches, which permit the generators to be brought up to speed as motors, and thrown in connection with the engines without stopping either engine. This makes it possible to connect either generator with either engine without shutting down the plant in any part. With such an arrangement, with the engine and generators equal to the maximum capacity of the plant, and battery auxiliary equal to one third the capacity of the plant, any office building can be operated in the most economical manner, according to the writer's belief, for when the battery is in operating order, one unit in conjunction with the battery handles the plant economically and satisfactorily, leaving one unit in reserve. In case the battery is out of service, both units can be operated until the battery is ready for service again, and during the light load period the battery auxiliary takes care of the entire service of the building, without the use of either the engine or generator units.

The engines are operated during the Summer compound condensing, by using a cooling-pan system and siphon condenser, as shown in section at the right hand of Fig. 1. With this arrange-

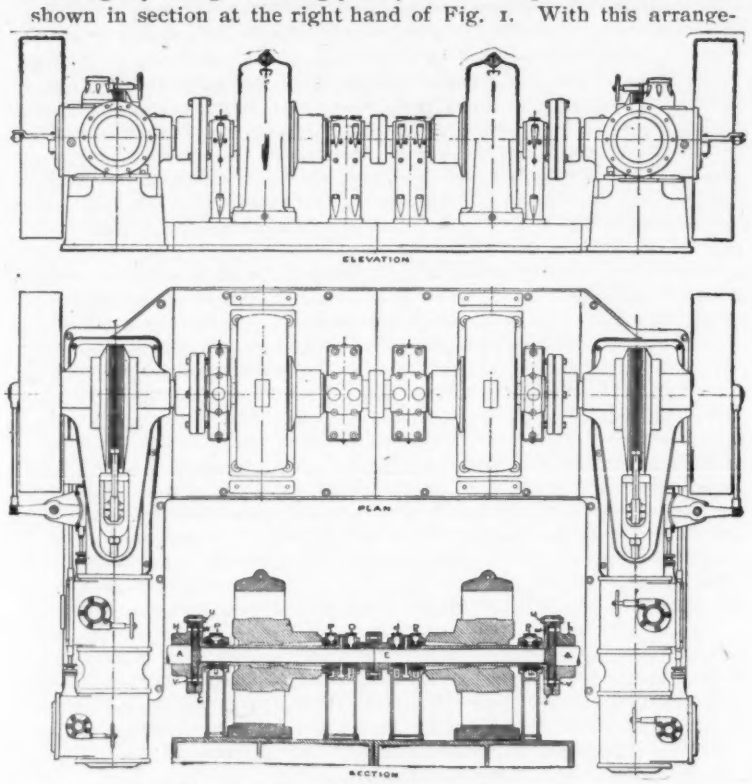


FIG. 5.—ENGINE PLAN AND ELEVATION.

ment the condensing water is cooled by means of the 72-inch ventilating fan which is in operation during the entire 16-hour run of the plant, and is used for ventilating the building. It was thought advisable to utilize the air from this fan for cooling the water, inasmuch as the energy for driving the fan had to be produced, and utilizing the air from the fan would not entail any additional expenditure of energy upon the plant over that required under ordinary conditions. The condenser is placed near the ceiling of the boiler-room and delivers into the standpipe extending downward into a pit about 35 feet. From the bottom of the pit a direct-acting deep-well pump lifts the water and delivers it to the cooling pans. From the cooling pans the water reaches through suitable piping the cistern shown on Fig. 1. From this cistern the injection pipe from the condenser leads. For this reason the plant will operate about six months of the year compound condensing, and during the balance of the year compound noncondensing, when the steam from the engines will be run into the mains of the building and used for steam heating.

Curious Röntgen Ray Effect.

To the Editor of The Electrical World:

SIR:—The curious effect of Röntgen rays, noted by F. C. K. Laflamme, in the May 16th issue of THE ELECTRICAL WORLD, is no doubt due to the electrostatic discharge that occurs from the iron plate forming a part of the plate holder. The white areas noticed occur in both cases at the parts of the foot and shoe where the contact is closest to the photographic plate. Thus the plate acts as a dielectric: the foot as one coating, and the sheet of iron as the other coating of a condenser, the Crookes tube serving to charge the same.

If the effect were due to the presence of moisture only, then there would be an absence of the filamentary radiations of the spots so characteristic of electrical discharges. The effect will disappear when a non-conducting plate is substituted for the iron back.

TURNER D. BOTTOME.

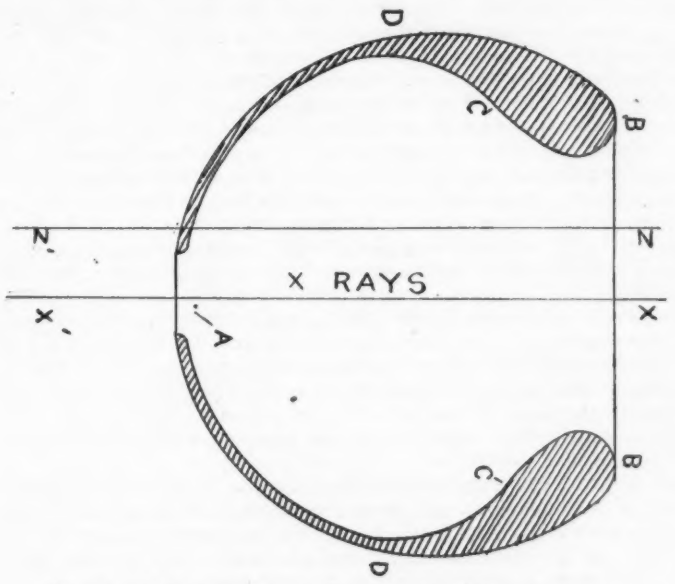
INDIANAPOLIS, IND.

Action of Röntgen Rays on Charged Surfaces.

To the Editor of The Electrical World:

SIR:—The most puzzling feature about Röntgen rays is that their course can not be deviated from straight lines. In consequence reasonings similar to those which enabled one to draw conclusions as to the nature of ordinary light, from the now classical experiments, cannot be as yet attempted for the Röntgen rays. It has been found that Röntgen rays will produce the discharge of a charged surface on which they impinge, and it would seem natural that this action should be attended by a reaction of the charged surface upon the rays. It would be interesting to investigate and determine whether such a reaction takes place or not, and if it does it would afford a starting point for drawing conclusions as to the nature of the rays.

The charged surface may cause either a reflection, or a deflection of the rays, or both. It may also, even without changing their course, alter their nature by polarization or by changing the phase, and this would be detected by interferences.



PROPOSED APPARATUS FOR EXAMINING RÖNTGEN RAYS.

The first thing to try might be to interpose a hollow sphere charged to a high potential in the path of the rays. A thin rubber ball, aluminum plated, would absorb very little of the rays when not charged. If a deflection occurs hollow prisms with rounded edges would be used. Two parallel surfaces would probably act like a plate of glass on light when the two surfaces are at the same potential, different from that of the surroundings; but they would act in quite another manner when the surfaces are charged oppositely, forming a condenser.

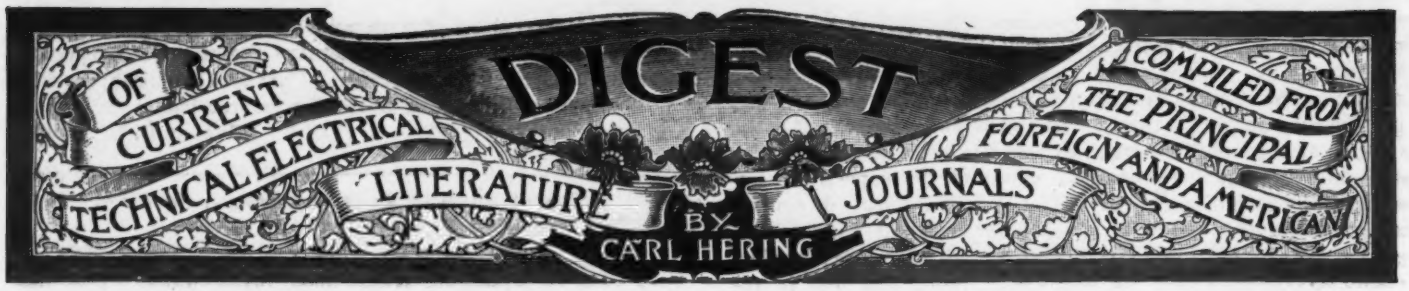
In order to submit the rays to the action of a single surface one might use a body, shaped as is shown in the figure. A is a very small aperture, B a much larger one. The body might be formed by the rotation of the loop A, D, B, C, A, around $x\ x^1$, and the outer surface A, D, B might be highly charged while the inner surface would have but a slight electric tension. The ray $z\ z^1$ would therefore pass through only one highly charged surface, while the ray $x\ x^1$ would not traverse any such surface.

A highly charged powdered insulating substance would probably show an increased absorption or a dispersion of the rays, even if the effect with one or two surfaces is not sufficiently marked to be detected. It would also be interesting to know if and in what manner the rays would be influenced when they are passed through a conductor traversed by a strong electric current.

As I have not an opportunity to make such experiments myself, I write these short notes down with the hope that some one more fortunate than I will find a way of determining what takes place under these conditions, and that he may draw interesting conclusions therefrom.

PAUL A. N. WINAND.

PHILADELPHIA, PA.


DIGEST
OF CURRENT TECHNICAL ELECTRICAL LITERATURE
BY CARL HERING
COMPILED FROM THE PRINCIPAL FOREIGN AND AMERICAN JOURNALS

DYNAMOS, MOTORS AND TRANSFORMERS.

Influence of the Shape of the Wave on the Iron Losses of Transformers. BEETON, TAYLOR and BARR. Lond. *Elec.*, May 15; beginning of a reprint in full of an Institution paper, describing and giving the results of tests made about a year ago.

Faults in Dynamos. Amer. Electrician, May.—The first part of a serial, which intends to give practical hints.

LIGHTS AND LIGHTING.

The True Resistance of the Arc. FRITH and RODGERS. Lond. *Elec.*, May 15; an abstract of a Physical Society paper.—Prof. Ayrton defines the true resistance of an arc as the ratio of a small increase in the voltage between the carbons to the corresponding change in the current, from which it follows that this resistance must be a negative quantity; in order to measure this without altering the form of the carbons, etc., they superposed a small alternating current on the main continuous current and measured the length of the arc; the continuous current and voltage were measured by Weston instruments, and the alternating current by an air transformer and an electrostatic voltmeter. They found that between the limits used the alternating current did not influence the results, and the frequency and the wave form had not influenced the resistance; four combinations of cored and solid carbons were used; the general characteristic of the curves is that for both carbons solid the true resistance is always negative, while, when both were cored, it is always positive; the other curves being between these two extremes, those which have a positive solid carbon being always more negative than those which have a positive cored carbon; when both carbons were solid, the relations between the resistance and the voltage are a minimum (a maximum negative) at about 55 volts; when the positive is cored this maximum is more strongly marked than for curves of a lower voltage; for cored carbons the position of this minimum is closely connected with the dark space in the arc; carbons with plaster of paris or kaolin cores have a positive resistance; in these experiments the positive carbon was uppermost; with the arc inverted and with solid carbons there is no appreciable alteration in the resistance, but with cored carbons the resistance is altered except when the dark space is absent. In attempting to measure the resistance of a direct-current hissing arc it was found that the current was oscillatory; an attempt to run the arc from a continuous-current dynamo failed, as there was a large deflection in the electrometer due to the oscillation of the current caused by the commutator. In the discussion Prof. Gray questioned the right to give the name of true resistance to the slope of the curve connecting the voltage with the current; the method was correct only if the curve was a straight line. Mrs. Ayrton stated that the evidence tended to show that there was no existence of a back E. M. F. Prof. Ayrton stated that it is necessary to separate the resistance and the back E. M. F. and to take a series of values; if a back E. M. F. really exists it follows that the arc must have negative resistance. Mr. Carter suggested that a negative resistance implied a back E. M. F. in order that the arc might be stable. Mr. Campbell stated that if a pulsating current were passed through a thermopile there would be a back E. M. F., while if an alternating current were used there would be no back E. M. F. Mr. Frith stated that according to Mrs. Ayrton an arc will not run unless there is a certain resistance in series with it and that therefore this resistance must be numerically equal to the negative resistance of the arc itself. The subject is also discussed editorially; the corollary to negative resistance is a back E. M. F., for if the true resistance is wholly and really negative, the loss due to the current and resistance in overcoming it must also be negative, in other words the true resistance must absorb heat; but there is a large amount of heat actually generated and as this is not generated in overcoming resistance, the only conceivable way is that it is developed by a back E. M. F.

Counter E. M. F. of the Arc. ARNO. *L'Eclairage Elec.*, May 2.—An abstract of the article from *Wied. Ann.*, which was abstracted in the *Digest*, March 14.

Analytical Study of the Alternating-Current Arc. FLEMING and PETAVEL.—A reprint in full with the curves and tables, of their long paper which was abstracted in the *Digest*, March 28 and April 4.

Arc Lamp with Inclined Carbons. Zeit. f. Beleucht., May 10.—An illustrated description taken from the German patent to BUB for a lamp in which the arc forms the lowest part, one of the carbons being slightly inclined from the vertical and the other almost at right angles to it, so that the light from the arc is all thrown downward; the arc is kept in its place by means of an electromagnet; the lamp is very short, there is no shadow cast by the carbons and all the light is thrown downward.

Arc Lamp. L'Elec., May 9.—An illustrated description of the ECK lamp; it is a focusing lamp and contains no mechanical mechanism for regulating it, the movement of the carbons being obtained simply by means of magnetic action; there are two solenoids with long cords which move the two carbons in opposite directions; to balance for the consumption of the carbons there is a small adjustible connterweight on a pulley over which a cord, on which the carbons and cords are suspended, passes.

Energy Required in the Moore Vacuum Tube Lamps. PERRY. *El'ty*, May 27.—An account of the data of some measurements made by Dr. Nichols, Prof. Anthony and Mr. Perry, of the energy consumed at the exhibit of these tubes in the Electrical Exposition in New York. The correctness of Mr. Wetzler's tests (which were reported at the recent Institute meeting) had been questioned owing to the pulsating character of the current and its effects on the measuring instruments, and the present tests were therefore made. The generating apparatus consisted of a 110-volt meter driving a 500-volt dynamo from which the current was taken for these tubes; there were in all about the equivalent of 16 tubes, 7.5 feet long and 1.75 inches in diameter; to avoid the effect of the interrupted currents, the current in the motor circuit was measured and an allowance was made for the efficiency of the motor and dynamo, which was taken as about 80 per cent. for the combined efficiency; there was also in the light circuit a constant load of a bank of incandescent lamps, and the current was measured when this load was on alone and when the Moore tubes were added to the circuit; a large number of tests were made, the result of some of which are given, but the successive readings were not very concordant; however, a condition of stability seemed to be reached when it was found that about 981 watts were expended on the tubes; therefore each of the tubes received about 61 watts at the motor terminals or 48.8 watts, after allowing for the loss in motor and dynamo; Mr. Wetzler's figures averaged 52.13 watts, and the close concordance practically disposes of all the questions of the adaptibility of direct current instruments, and the agreement is strong presumptive evidence of their substantial correctness. No tests of the illumination were made; (no estimate is given of the relative illuminations produced by these tubes and by incandescent lamps consuming the same amount of energy in the same room; such an estimate made by these authorities would have added greatly to the interest of the results).

X-Ray Light Tube. Elec. Rev., May 27.—A brief description of what is said to be an important discovery of Mr. Edison; he found that a certain mineral (the name of which is not given) possesses the property of turning X-rays into light; it fluoresces more strongly than tungstate of calcium; an ordinary Crookes tube is coated with crystals of this mineral on the inside surface, and contains aluminum electrodes; it is used as in the usual X-ray apparatus, and the rays are thereby turned into light, the absorption being almost perfect and there being very little heat; the bulb gives a pure white fluorescence; no X-rays can be detected from such bulbs; he thinks that all the electrical energy is transformed into light, which latter resembles bright sunlight and has none of the moonlight effects, the spectroscope showing plenty of red light in it; the lamps may be made of any size and may be operated in multiple arc; he is endeavoring to get this system into a commercial form; the best bulb so far made gives four candles; the mineral is said to be very cheap and the whole system is said to be highly economical.

Ornamental Electroliers. Amer. Electrician, May.—A number of illustrations of some very ornamental work.

POWER AND HEAT.

Two-phase Power Transmission at Romagnano. Lond. *Elec.*, May 15.—A brief, illustrated description of a large plant for a paper mill in Italy, erected by Brown, Boverie & Co. The power is transmitted from a waterfall three miles distant, has a capacity of 810 horse-power, and has been in successful operation for over a year; there are three two-phase alternators of 195 kilowatts directly coupled to the turbines; the alternators have a fixed external ring armature and the conductors are imbedded in the iron, thus enabling the pole-pieces to be constructed of solid metal, as there are no eddy currents in these; of the 28 poles, one half are cast on the frame and the other half are secured by bolts, only the latter carrying the coils; this arrangement enables cylindrical coils to be used without loss of space; both bearings supporting the vertical shaft are below the body of the inductor; the frequency is 83 and the dynamos generate 3600 volts directly. Parallel coupling is accomplished by lamps fed by three

200-watt transformers, to which the voltmeters are also connected; a fourth transformer shunted from the main bars, is in series with the lamp circuit, and synchronism is therefore indicated by the incandescence instead of, as usual, by the obscurity of the filaments. At the further end the current is transformed down to 230 volts and is used for motors and lights, including six motors of 120 horse-power each; the secondary network consists of only three wires, one of which is a common return. The inductor of the motors is external and fixed; to obtain full torque at starting and to prevent an extraordinary flow of current from the line, a resistance is inserted in the armature circuits which is switched out when full speed is attained, by means of a screw which is operated by hand while the armature is revolving; tests of the plant show that the efficiency of the whole electrical transmission is equal to 80 per cent.; that is with 810 horse-power at the turbines, 648 are delivered to the motors.

Electric vs. Hydraulic Elevator. BAXTER. *Eng. Mag.*, June.—An article discussing the relative merits of the two systems. The electric elevator originated in order to supply a demand for which the hydraulic was not applicable; in the matter of certainty of control the hydraulic is undoubtedly superior, but it is possible that the electric elevator may be made equal to it in this respect, and in every other direction it is superior even to-day; the main features of both systems are discussed in order to show their relative merits; as the electric has no storage device the engine must be of a capacity necessary for the maximum demand at starting, which is far above the average; where a number of elevators are in the same building this factor is of less importance; with a plant of five or six cars or over there is little doubt that the cost per unit of energy delivered at the car will be lower with the electric system, and therefore the total cost of the energy will be less; with an electric elevator of the drum type the energy required can be made much less than with a hydraulic, due to the fact that the weight of the car can be overbalanced; the energy at starting is much greater than the normal, which cuts down the average efficiency considerably, but the maximum velocity will be attained sooner and, therefore, a lower maximum is compatible with the same average velocity; this, therefore, partly offsets the loss; the hydraulic cylinder must be of sufficient capacity to start the car with a maximum load, and the energy used at all times must, therefore, be equal to that absorbed at starting; if very high velocity is attempted with cars counter balanced directly, the weight of the latter must be very much reduced to insure safety, which means that the efficiency, as compared with a machine of the drum type, will be reduced with the increased velocity. He believes that the certainty of control of the electric elevator can be made equal to that in the hydraulic, but up to the present time only one company appears to have adopted an electrical controlling system exclusively, as the difficulties encountered are very great; the prospects of the electric system are much brighter. He thinks it better to take the current from the street mains for elevators, as well as for lights, even in large buildings, notwithstanding that the energy may cost more, as it does away with all the machinery; he thinks the electric elevator may eventually drive the hydraulic out of the field; this discussion was confined to drum machines, as these are the more usual, although the screw type may become the standard in the future.

TRACTION.

Dublin Railways. Lond. *Elec. Eng.*, May 15.—A very long, well-illustrated description of the trolley line from Dublin to Dalkey, constructed apparently on the American system; it includes a three-phase transmission plant, which is the most extensive application of that system in that country; the current is generated at 2000 to 2500 volts, and is transmitted by concentric cables to the sub-station, where it is transformed by rotary transformers to a 500-volt direct current; a battery of accumulators is used, but only for lighting the generating station.

Surface-Contact System in Paris. *L'Eclairage Elec.*, May 2.—A brief description, with an illustration of the switchboard, of a plant which is being erected in Paris, in which Claret-Vuilleumier system is to be used; the plant will soon be finished and description of the details is promised in a later article (descriptions of the system have been referred to a number of times in these columns).

Disturbances in Telephone Conductors Due to Electric Railways. WEST. Lond. *Elec.*, May 15.—A translation of the article abstracted in the *Digest*, May 23.

Earthing Device for the Protection of Telephone Circuits. ULBRICHT. Lond. *Elec.*, May 15.—A translation in abstract, with the illustration, of the article abstracted in the *Digest* last week.

Baltimore-Washington Line. *Elec. Ry. Gaz.*, May 10.—A note stating what progress is being made; it is thought that within a year cars will be running at such a speed as will bring the two cities nearer together by 10 or 15 minutes; the rails will be 85 pounds to the yard within the District and 75 pounds outside, and they are to be 60 feet in length; the cost per mile will be about $20,000.

Mountain Trolley Line. *Elec. Ry. Gaz.*, May 10.—A note stating that a trolley line is to be built up the volcano Popocatepetl in Mexico, 18,000 feet high, and thence down into the crater where the sulphur is mined.

Mining Locomotive. *Eng. and Min. Jour.*, May 23.—A brief illustrated description of the Jeffrey 18-inch gauge electric mining locomotive used in a mine in Arizona; one of the advantages claimed for it is that it is constructed with interchangeable parts.

Rapid Transit Street Railways. FISHER. *Elec. Ry. Gaz.*, May 10.—A brief summary of all the laws enacted by the Legislatures of respective States in 1895 pertaining to rapid transit and street railways, together with the book references.

Repair of Electric Railway Apparatus. SHEPARD. *Amer. Electrician*, May.—An illustrated article on the General Electric controller, including diagrams of the connections.

Bridgeport. *Elec. Ry. Gaz.*, May 10.—An illustrated description of this road, which operates about 48 cars over 44 miles of double track.

Street Railway Appliances at the New York Exposition. *Elec. Ry. Gaz.*, May 10.—A brief account of the street railway appliances at this Exposition.

INSTALLATIONS, SYSTEMS AND APPLIANCES.

New System of Distributing Electrical Energy by Alternating Currents. HOSPITALIER. *L'Ind. Elec.*, May 10.—A brief description of the system devised by FERRARIS and ARNO. The general distribution is done by means of simple alternating currents which are used for lighting; where motors are used a second current of a different phase is produced, thus providing polyphase currents; it can therefore be used with existing single-phase alternating-current systems; the apparatus used is called a chasing transformer; a single-phase alternating current produces another in a different phase; it contains fixed primary and secondary coils and besides this an intermediary revolving part maintained in motion like the armature of a non-synchronous motor; for a two-phase device, for instance, there are two coils at right angles to each other in a magnetic field which includes a revolving armature; one of these circuits is connected to the central alternating-current mains; the rotation of the inductor gives rise to a revolving field and develops in the secondary circuit a current differing in phase by a quarter of a period from the first; in combining the secondary circuit of one of these transformers with that of an ordinary transformer, a two-phase current will be produced; there are a number of modifications according as one wishes to have a two or three-phase current; the characteristic of the system is the simultaneous use of two distinct transforming apparatus, one of which is stationary and the other turning. In this connection the writer calls attention to another system, which he thinks is more simple and ingenious, and was proposed two years ago by Prof. Potier (see *Digest*, June 16, 1894); the principle is as follows: A simple alternating-current motor, with a short-circuited revolving armature, develops in its inductor a revolving field of the same frequency; if this inductor contains a second winding, distributed regularly over its periphery, and if three connections be made to it 120 degrees apart, three-phase currents will be obtained from it; by merely changing the points of attachment of these branches a single-phase current may be transformed into two-phase currents; this, therefore, requires only one transformation in place of the two in the above-described system. The system of Ferraris and Arno may be used for traction; for normal speeds the current will be furnished by a double trolley wire as a simple alternating current; the rails forming the third wire would furnish an additional lead for a polyphase system, which would be used only in starting; a more detailed description is promised.

Notes on Polyphase Currents. GERARD and HENRARD; *L'Eclairage Elec.*, May 2.—A reprint of the article abstracted in the *Digest*, March 21.

Electrical Industries in Germany. BUSSET. *L'Ind. Elec.*, May 10.—The first part of an article giving an illustrated description of the principal apparatus manufactured by the more prominent companies in Germany; the present portion describes the products of the firm of Siemens & Halske.

Electricity on an Italian Cruiser. *L'Elec.*, May 16.—A short, illustrated description of the electrical equipment of the *Re Umberto*.

WIRES, WIRING AND CONDUITS.

Fuse Wires. STINE. *Amer. Electrician*, May.—An article giving a summary of the subject; he gives among other things the following conclusions; covered fuses are more sensitive than open ones; a fuse wire should be rated for its carrying capacity for the ordinary lengths employed; on important circuits fuses should be frequently renewed; fuses up to five amperes should be at least 1½ in. long, ½ in. to be added for each increment of five amperes capacity; round fuse wires should not be employed in excess of 30 amperes capacity; for higher currents flat ribbons of four inches and upwards should be used.

Interior Wiring. *Amer. Electrician*, May.—The first article of a series on the subject; the present portion is devoted to general instructions.

ELECTRO-PHYSICS AND MAGNETISM.

Cathode Rays and Their Transformation into Röntgen Rays. PULUJ. *Zeit. f. Elek.*, May 1.—An abstract of some length of a recent lecture. The first part is historical, describing the work of Crookes, Hittorf, Gintl, Rowland, Puluj and Lenard; of special interest is the lamp made by Prof. Puluj 14 years ago and is called the phosphorescent lamp, which not only gives a strong phosphorescent light but also very intense Röntgen rays, such that clear photographs can be taken in two seconds; the

lamp contains a plate of mica covered with calcium sulphide on one side and arranged so that the cathode rays impinged on it; it gives a greenish white phosphorescent light; it shows that X-rays come neither from the cathode nor the glass but from the coated side of the mica. In very rarefied gases the transformation of the energy of the visible cathode rays into Röntgen rays, takes place by means of the material bodies like the sulphide of calcium and glass, in such a way that the material particles torn off by the cathode rays carry by convection negative static electricity, and transmit their charge on striking the solid body, thereby producing not only an oscillation of the material particles but also of the ether surrounding them; each part of the screen which is acted on by the cathode rays becomes heated and is the origin of ether waves, which according to their amplitude and kind, are either visible rays which we see as phosphorescent light, or invisible rays; the latter are the rays discovered by Röntgen; they may be longitudinal, but Puluj thinks there is no evidence of this. He states that Winkleman and Straubel have increased the sensitiveness of photographic plates for Röntgen rays more than 100 fold by covering the plates with pulverized fluorspar.

Luminescence of Solid Bodies and the Action of Röntgen Rays. Arnold. *Zeit. f. Electrochem.*, May 5.—A description of experiments made with a number of solid inorganic bodies, solutions and organic substances, with respect to their luminescence on the action of the cathode, light and Röntgen rays; the chief materials examined were sulphides, selenides, cyanides and tungstates, solutions of earthy alkalies, magnesium and the earth metals; he found that the mineral scheelite and tungstate of calcium luminesces more than all other bodies, even brighter than potassium platino-cyanide; furthermore, prepared calcium tungstate luminesces less, while several other compounds of tungsten give no light at all; a solution of tungstate of copper in tungstate of calcium luminesces as brightly as scheelite; with this mineral he found that from the point where the cathode rays impinge X-rays are generated not only normally, but to all sides. As a general result he found that the production of luminescence is not the same with cathode as with Röntgen rays, and that with some materials there are great differences, while with others the effect is the same. The transparency of solutions to X-rays was examined, and it was found that the transparency is not affected by the addition of small quantities of soluble bodies; compounds of sulphur, selenium and arsenic are not transparent, while those of aluminum and boron are quite transparent; experiments with fluorspar on the action of bromide of silver plates to reduce the time of exposure gave negative results, as no difference was found when this material was used; the difference between this result and that of Winklemann, who claimed that the time of exposure was greatly reduced, may be due to impurities in the materials.

Visibility of Röntgen Rays. Lond. *Elec. Eng.*, May 15.—An extract from a report in the London *Standard*, giving a report of tests made by Dr. Brandes, of Halle, Germany; it is known that Röntgen rays do not reach the retina, as the lenses of the eye are practically opaque; experiments were therefore made made with a person whose lenses had been removed in an operation for cataract, and it was found that the rays became visible to the subject, even when an aluminum plate had been interposed so that there could be no confusion between the light of the bulb and the effect of the rays; it is furthermore added that if sufficient precautions are taken to exclude all ordinary light, the X-rays can be observed by the normal eye, being transmitted not through the lenses, but through the region of the sclerotic; all that is possible to see would be a sort of indefinite sensation of light. It is stated editorially that the results must be accepted with extreme caution.

Diffraction of Röntgen Rays. Calmette and Lhuillier. *L'Ind. Elec.*, May 10.—A brief abstract from an Academy paper, in which they appear to have shown a diffraction of the rays; it was not distinct enough to enable them to measure the wave length with precision, but they believe that it is greater than that of the luminous rays.

Röntgen Rays. Lond. *Elec.*, May 15.—A brief mention of several papers in the *Nuovo Cimento* by a number of Italian physicists, some of which are said to be of the greatest importance. Batelli found by a triangulation method that the rays appeared to start from the surface impinged upon by the cathode rays; he also found that Crookes tubes emit X-rays for some time after the discharge has ceased; he claims priority of the discovery that the exposure may be shortened by placing the fluorescent screen behind the plate, and states that the same object may be achieved by placing strongly fluorescent substances inside the tube. Vincentine and Pacher claim to have irregularly reflected the rays by means of a large parabolic mirror of brass. Righi described a way of obtaining images independent of photography; the tube is placed above a metallic plate, which together with the cathode is connected to one pole of the charged condenser; above the metal is a discharged ebonite plate, and between this and the tube is a sheet of black cardboard coated with aluminum foil connected to the anode and the earth; the object is placed on the cardboard, and after exposure the ebonite plate is dusted with a mixture of sulphur and red lead, or talc and manganese dioxide, when the picture will come out clearly. Salvioni showed a photograph in which the cartilages of the hand were more opaque than the spongy portions of the bones; also a picture of a frog, showing the lungs, heart and spleen. Villari claims to have reflected the rays by means of a plate of zinc, in accordance with the ordinary laws of reflection, and states that no other substance showed this phenomenon.

Röntgen Rays. S. P. Thompson. Lond. *Elec.*, May 15.—A brief editorial notice of a recent lecture at the Royal Institution. In one experiment a sheet of ebonite was electrified, and then electrostatically screened and exposed to the radiation; on dusting with the usual powdered mixture, the dis-electrifying action of the rays was shown by the development as a dust figure of the shadow of an object interposed between the X-rays source and the ebonite plate. He also found that the diamond although much more transparent than glass, is more opaque than block carbon or graphite. With a Crookes tube he finds that one cannot obtain two shadows of an object by using two cathodes, from which it follows that cathode rays are not mere wave motion; it is intimated that with a special arrangement, just discovered, that can be done; the photographic action is improved by directing the cathode discharge on a metal surface or on an enamel containing lead; heating the anti-cathode is also found to be an advantage; X-rays affect the brush discharge in air of an influence machine; the transparency of materials to these rays is more nearly proportional to their specific heats than to the reciprocal of their atomic weights; bodies which emit visible rays when X-rays fall on them, emit X-rays when exposed to light.

L'Elec., May 15, contains some brief abstracts from recent papers read at the French Society of Physics; Chappin succeeded in producing instantaneous photographs of metallic objects, that is, in the time of a single discharge of the coil; photographs of the hand were obtained in two seconds; photographs were also obtained of the thickest parts of the human body; he also found that a focus tube has the advantage that it retains its power longer, as the glass is not altered thereby in the portion traversed by the rays.

The Lond. *Elec. Rev.*, May 15, quotes from the *Photographic News* stating that according to Mr. Payne when dry plates are packed in tin lined cases and forwarded by steamers lighted by electricity, there is risk of injury from induced currents which may be communicated from the dynamo, especially if the vessel is wired on the one-wire system.

Photographs in the Interior of Crookes Tubes. Metz. *L'Ind. Elec.*, May 10.—An abstract of an Academy paper describing experiments in which photographs were made in the interior of the tubes by means of cathode rays; the objects were a cross of copper and a disc of zinc, partly covered with a plate of platinum; 12 such photographs were made, from which it appears that cathode rays have one of the properties of Röntgen rays, as they penetrate aluminum, cardboard, sensitive paper and a film, but are stopped by platinum and copper. A note by Poincare states that these photographs are not absolute demonstrations of the fact that cathode rays have the essential properties of Röntgen rays, as the former impinging on the platinum generate Röntgen rays, which may then traverse the metallic plates.

Viscous Dielectric Hysteresis. Arno. Lond. *Elec.*, May 15; translated from the Italian.—There are two kinds of lag in dielectrics which may produce the dissipation of energy in his well-known experiments. There is either a lag in the variation of the dielectric constant or there is a time retardation, which latter he calls viscous dielectric hysteresis; he shows that its existence follows from a number of experiments made by others and he gives the results of those undertaken by him in order to test whether this dissipation of energy in a rotating field must also, like in an alternating field, be partly attributed to viscous dielectric hysteresis; the latter is a function of the velocity of rotation, hence he used a uniform field and varied the velocity; he used two equal fields at 90 degrees with each other and varied the frequency of the current; the results show that the energy dissipated in each cycle varies with the rate of rotation and that therefore that energy or part of it, is the effect of viscous hysteresis.

Transparency of Filaments. Allingham. Lond. *Elec.*, May 15.—Referring to the note by Cassels abstracted in the *Digest*, May 16, he states he noticed in frosted lamps with a plain horseshoe filament that a distinct shadow of the filament is cast all around the bulb which would appear to indicate that the filament is opaque; the lamp was run at about 2.5 watts per candle.

Magnetism. Ascoli. *Nuovo Cimento*, abstracted in the *Proc. Lond. Phys. Soc.*, May.—He describes experiments giving quantitatively the amount of disturbances caused by a magnetic substance when placed in a uniform field, and concludes among other things that there is absolutely no superficial protective action by the outermost skin of the magnetic substances; the other conclusions are given in abstract.

Magnetic Field of a Cylindrical Coil. Everett. *Proc. Lond. Phys. Soc.*, May.—An abstract of the paper which he read last November, giving some of the mathematical relations.

Rotational Motion of the Cathode Disc in a Crookes Tube. Nipher. *Elec. Rev.*, May 27; a reprint of a short paper read before the Academy of Sciences, May 4.—The equations which represent the properties of the magnetic field external to a conductor are inconsistent when applied to points within the body of the conductor itself; he thought that this failure of the equations must be the result of leaving some elements of the problem out of the discussion; recently he observed that the circular aluminum disc of the cathode in the Crookes tube became slightly loose on the wire and that it was constantly rocking in a rotary motion; when

it became loosened it began to rotate slowly on the wire as an axis, the direction of rotation being contrary to that of the hands of a clock when viewed from the point where the wire passes through the tube; all attempts to accelerate or retard the motion by means of a strong bar magnet, as in Barlow's wheel, were without effect; placing the tube at various distances from the coil and giving the disc all possible positions in the earth's field produced no change in the rotation; when the loose disc was made the anode no tendency to rotation was observed, and all attempts to produce the effect in air failed; it seems that the vacuum must be very high; he is now constructing tubes for researches in this direction; it is thought that the cathode discharge is a direct active agent; it is possible that the rotation observed is a direct action and reaction between the current in the disc and the external field due to the current; whatever may be the direct agency producing this rotation it seems apparent that it is an experimental basis for imposing a term representing a rotation into the equations representing the conditions within the conductor.

How to Make and Use a Tesla High-Frequency Coil. WOODS. *Elec. Rev.*, May 27.—A brief, illustrated description of a simple form of apparatus. A wooden spool is made 3.5 inches outside diameter, with the interior turned down to 2.5 inches diameter; a wooden cylinder is turned 2 inches in diameter and 14 inches long for the primary, which is inserted in the hole through the wooden spool, the length of the spool being 13 inches; for the primary a No. 18 double cotton-covered wire is wound in a single layer, and for the secondary a No. 36 double silk-covered wire is wound in a single layer; both are shellacked, and the wood should be boiled in paraffine; the coil is operated by an ordinary spark coil giving at least a 2.5-inch spark, with a Leyden half-gallon jar connected in the usual way, so that its discharge passes through the primary of the Tesla coil in series with a spark gap, which should be made as great as the jar will permit; the effect may be increased by making the spark gap smaller and using an air blast; for producing Tesla effects the coils should be placed in oil.

Crookes Tubes and Experiments with Röntgen Rays. DUNCAN. *Amer. Electrician*, May.—A short article describing some of his experiments; he found that there was an increase of rarefication in the lamp which he thinks is due to the air combining with the carbon, and being precipitated as a solid on the glass; he calls attention to the inefficient tubes which are sold in the market for producing X-rays; he thinks an improvement will have to be made in the ordinary method used for exhausting bulbs, and describes the following process used by Crookes to prevent mercury vapor from getting into the bulb; when exhaustion has taken place a small quantity of iodine is placed in the tube connecting the bulb with a high vacuum chamber and nearest the latter; this absorbs the mercury vapor, then some sulphur which absorbs the iodine vapor, and lastly powdered silver, which absorbs the sulphurous vapor. He found that by suppressing the cathode rays from one of the terminals there is an increase from the other; he also applied an external electrode of tinfoil to the end of a tube opposite the electrode whose cathode stream is thrown out horizontally and found that the stream thrown off from the other electrode was increased; he also grounded this external electrode, producing a still stronger effect.

Röntgen Rays. Elec. Rev., May 27.—A statement that according to the London *Lancet*, in an experiment to ascertain the possibility of photographing a bullet in the head of a child, it was found that 21 days afterwards the hair came out in the region exposed to the rays. The American journal adds that this method might be used to replace shaving.

Röntgen Ray Outfit. Amer. Electrician, May.—The first part of a serial giving an illustrated description of how to make the complete outfit.

ELECTRO-CHEMISTRY AND BATTERIES.

Electric Tanning. ROEVER. *Wied. Ann.*, Vol. 57, page 397; abstracted in the *Proc. Lond. Phys. Soc.*, May; the title of the paper is "Electric Endosmosis of Tannin Solutions Through Animal Membranes."—He used pieces of cowhide in tannin solutions; the leather was used as a sort of diaphragm between two vessels containing the solution; when no current was passing no liquid went through it, but as soon as the circuit was completed the liquid passed through the hide in the same direction as the current, and varied during the first minute approximately as the E. M. F., but was not related in any simple manner to the strength of the current; one volt will drive through a piece of hide of one sq. cm. in area 0.000002048 gr. of 0.2 per cent. solution per second, or 100 volts will drive 7.377 kg. per hour through an area of one sq. metre; the resistance of the hide was 1.282 ohms per sq. metre; the strength of the current increases rapidly on completing the circuit, attaining a maximum in a few minutes and then falling off again, this phenomenon being repeated on reversals, and appears to be due to the alteration of resistance by the choking up of the pores; he concludes that in actual tanning the maximum circulation of the liquid through the pores is obtained by reversing the current every few minutes.

Applied Electro-Chemistry. SWINBURNE. Lond. *Elec.*, May 15.—A brief notice of his third Cantor lecture. Regarding tin scrap, he stated that there was no difficulty in recovering the tin electrolytically from a solution of hot caustic, but added that there seemed to be no scrap in the market for sale. The real difficulty in the electrolysis of salt is not in the anode or cathode, as most kinds of carbon did fairly well for the former, and almost any material will answer for the latter. The problem was to collect the products; the small amount of sodium obtained was also puzzling; examining the salt left on the electrode, it was seen under the microscope to contain black specks, developing a gas under water, which looked as if the sodium were deposited not on the electrode but in its vicinity, and a lot of it was therefore carried away; in obtaining chlorine by the wet process, using carbon electrodes, a certain quantity of carbonic acid gas is formed, which passes off with the chlorine into the lime, thus forming chalk instead of bleach.

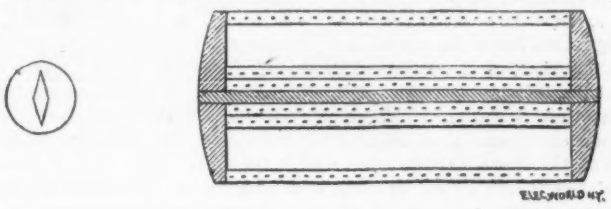
Electro-Chemistry and the Technic of Energy. BUCHERER. *Electrochem. Zeit.*, May.—A short article giving mathematical deductions from his theory of electrolysis and a proof that the hypothesis of Nernst and Ostwalt is in contradiction with the requirements of the theory of energy; (for his theory see *Digest*, Jan. 18 and 25).

Constant Galvanic Cells. HEIL. *Elektrochem. Zeit.*, page 245, abstracted briefly in the *Proc. Lond. Phys. Soc.*, May.—After discussing the cells at present in use, such as the Bunsen, Grove, etc., he describes a new one invented by him which in practice resembles the Leclanchè; "an electrode of silver sulphide-copper, prepared by a patented process of the author, is connected with zinc and ammonium chloride used as an electrolyte;" the current is exceedingly constant and is said to have a remarkable duration; when not in action nothing is consumed provided the zinc is well amalgamated.

Evolution of the Storage Battery. Lond. *Elec.*, May 15.—The paper of Mr. Barnett mentioned in the *Digest*, April 11, is discussed editorially.

UNITS, MEASUREMENTS AND INSTRUMENTS.

Permeability Bridge. CHITTOCK. Lond. *Elec.*, May 15.—A short communication describing an apparatus based on the same principle as the Ewing bridge illustrated in the *Digest* last week, and which has been in use for the past six months. Referring to the accompanying diagram,



the test piece passes through the centre, the two end discs being soft iron; there are three cylindrical coils, of which the latter two have the same number of turns and each are connected in series, so that the current through them circulates in opposite directions; a current is then passed through one coil and another through the other two in such directions that the lines of force are drawn back through the air space between the two outer coils, and by suitably adjusting these currents the difference of magnetic potential between the end discs may be reduced to zero, which condition is indicated by the compass needle; the air space in this takes the place of the standard bar in Ewing's apparatus and by thus using the air as a standard instead of iron, certain simplifications are obtained; one of the currents is proportional to the magnetizing force and the other to the induction in the iron, and the ampere-meters therefore give values proportional to these; the instrument, moreover, is absolute, both magnetic quantities being obtained by calculation; by means of sliding resistances a complete curve may be taken in a few minutes. A small error arises in that the lines of force of those drawn back by the outside coils include a few air lines which pass outside of the test piece in the inner coil, but this is almost negligible and may be completely overcome by winding on the coil of the ammeter in the outside circuit a proper number of opposing turns and passing the outside current through them.

Legal Electrical Units in France. L'Ind. Elec., May 10 and *L'Elec.*, May 6.—A reprint of the legal documents concerning the obligatory use of the international system of electrical units. The first article refers to the obligatory use of these units; the second defines the ohm as the resistance of a column of mercury at the temperature of melting ice, having a mass of 14.4521 gr., a uniform cross-section and a length of 106.3 cm; article 3 defines the ampere as the 10th part of the electromagnetic unit of current, which is represented with a sufficient accuracy for practical purposes by a current which deposits 0.001118 gr. of silver in a second; article 4 defines the unit of E. M. F. as that which will sustain an ampere in a conductor whose resistance is an ohm, and is represented with sufficient accuracy for practical purposes by 0.6974 part of that of the Clark cell (this seems to correspond to the value 1.434); no other units are defined nor are any terms such as "International," "Legal," etc., used in connection with these units. It is followed by a recent report of a committee of which Violle was chairman, discussing the subject of units and the work of previous congresses; in this the unit of light suggested was that emitted by a square centimetre of platinum at the temperature of solidification, but no such unit is included in the document which became a law April 25, 1896. It is followed by appendices describing the voltmeter for measuring the current and the method of making Clark cells.

Localization of Faults in Electric Light Mains. Lond. *Elec.*, May 15; a continuation of his serial, see *Digest* last week.—He describes the Weston circuit-tester and the Hartmann and Braun leakage indicator; this is followed by a description of two methods due to Froehlich, described some years ago; in the first, a voltmeter is used, with a resistance which is high compared with the insulation of the mains and which reads to both sides of zero; it need not be direct reading; this is connected between one main and the earth, and the reading taken, after which it is shunted by a resistance, which is adjusted until the new reading is half of the first; the resistance of the shunt is then equal to the insulation resistance of the network; the theory is given, in which it is shown that g (presumably the galvanometer resistance) should be so large that its reciprocal can be neglected when compared with the reciprocal of the fault resistance; this is said to be a very practical method for three and five-wire systems of moderately high insulation—say about 100 ohms; if the galvanometer resistance is not sufficiently high a resistance coil must be put in series within, and the shunt, of course, must embrace both the galvanometer and this resistance. In another method which is a modification of the preceding one, an ammeter or voltmeter is connected between one of the mains and the earth and the reading taken, after which the instrument is shunted by a resistance exactly equal to its own and the reading again taken; the insulation of the network will then be equal to the galvanometer resistance multiplied by the difference between the readings and divided by twice the second reading minus the first; this method is suitable for high and low insulation and the formula is absolutely correct; the instrument should preferably have a resistance about equal to that of the insulation, and if it is lower a resistance coil should be added in series with it; when the fault resistance of the positive and negative sides nearly balance one another, it is still possible to obtain the readings from the middle wire by inserting a known resistance between one of the other mains and the earth, as an artificial fault thus destroying the balance; from the results obtained the true resistance is then calculated by making the proper allowance for the additional fault.

Modified Wheatstone Bridge. Lacoine. *Jour. Teleg.*; reprinted in *L'Elec.*, May 16.—A brief description showing how an ordinary bridge box containing only the ratios 10, 100 and 1000, can be used also for ratios of 1 to 1000 without the addition of any expensive instruments. The bridge must have the adjustable resistances 1000 to 5000, connected so that the 5000 end is connected to one of the bridge resistances; at this point the galvanometer is usually connected; in the present method this connection is removed and the galvanometer wire is connected to the block marked 1000, thus adding to one side of the bridge resistance the coils marked 5000, 2000 and 2000, which together with 1000 of the bridge resistance makes 10,000; the block 10 and 100 on that side and 100 and 1000 on the other are plugged up, thus leaving the ratio 10,000 to 10.

Increasing the Sensitiveness of a Galvanometer. Abraham. *L'Eclairage Elec.*, May 9, *L'Ind. Elec.*, May 10; and *L'Elec.*, May 9.—A reprint of a short Academy paper in which he describes a method to be used with the movable coil type of galvanometer known as the d'Arsonval type; by means of the usual method of increasing the sensitiveness the latter can never exceed that of the galvanometers with magnetic needles; in the present method the directing force is reduced to any desired amount by compensating for it; this is accomplished by balancing the torsional force by means of a weight on the coil, and tilting the instrument so that the eccentric weight tends to balance the torsion; in this way he states that the sensitiveness is increased 100 fold and is equal to that of a Thomson galvanometer of the same resistance.

Thermophone. Meyer. *Zeit. f. Elek.*, May 1.—A short article describing the improvements in the Warren and Whipple instrument (see *Digest*, Nov. 30).—In the original instrument errors are likely to arise, as, for instance, in the sliding contact, and each apparatus must have its own source of current; small differences of temperature would not be noticed; the present arrangement is claimed to overcome these difficulties; the temperature in a number of different rooms can thereby be measured from one point with one galvanometer; the same general arrangement of a bridge is used, and the galvanometer wires are all brought to one switch at which contacts may be made with any one of them, the current in the galvanometer being measured instead of attempting to make a balance; he states that carbon and copper would answer better, as their temperature coefficients vary in opposite directions; an illustration is given; (it appears, however, that a modification in the switch is necessary before the arrangement could be used in practice, as some parts of the bridge are short-circuited by the leads).

Determination of High Temperatures with the Meldometer. Ramsay and Eumorfopoulos. *Proc. Lond. Phys. Soc.*, May.—A reprint in full of their recent paper abstracted in the *Digest*, March 21.

Measurements in Engineering. Kennedy. Lond. *Elec.*, May 15.—Reprint of the complete James Forrest lecture on "Physical Experiment in Relation to Engineering."

TELEGRAPHY, TELEPHONY AND SIGNALS.

Earth Telegraphy. Stricker. *Zeit. f. Elek.*, May 1.—A short article of a historic nature reviewing briefly what has been done in telegraphing without wires, as in the Preece and Rathenau systems.

Duplex Cable Working. Lond. *Elec.*, May 15.—A brief extract with an illustration, from a pamphlet recently issued for the working staffs of several of the leading cable companies, giving a series of hints to duplex operators.

MISCELLANEOUS.

Lightning Statistics During Eight Years in Japan. *Elec. Friend* (Japan) April.—The statistics are given in the following table:

	1887	1888	1889	1890	1891	1892	1893	1894	Average per year.
Killed (Men).....	19	3	5	21	32	64	24	93	32.6
" (Women).....	10	2	1	10	20	20	14	33	13.7
Injured (Men).....	16	3	20	8	9	38	14	23	16.3
" (Women).....	3	2	0	7	8	15	2	6	5.3
Killed (Oxen).....	0	0	0	2	1	5	3	5	2.0
" (Horses).....	4	0	3	3	1	9	1	13	4.3
Houses totally burned...	31	18	11	38	19	67	11	84	35.0
" Partially burned.	5	0	3	9	7	20	2	3	6.1
" Damaged.....	7	1	1	7	8	31	2	8	8.1

From January to March there were almost no cases, while July is the most severe month.

Death by Electricity. Darin. *L'Eclairage Elec.*, page 398. Abstracted in the *Proc. Lond. Phys. Soc.*, May.—In some experiments made on animals, as well as in 26 executions in New York State, it was found that after the passage of an alternating current the physicians declared death absolute; in the autopsies organic lesions and inter-cranial effusions of blood were found in only two cases, there being no organic alteration in the other cases, and he concludes that death was due to stoppage of respiration and syncope; when the lesions did not exist, death is only apparent and respiration would be possible; there is scarcely any means of affirming death except by having thoroughly attempted respiration without success.

Influence of Induced Currents on Living Bacteria. Lortet. *L'Ind. Elec.*, May 10.—An abstract of an Academy paper in which he states that he found movable bacilli to be very sensitive to the influence of induced currents, and to immediately place themselves parallel to the path of the current; he concludes from his numerous experiments that living bacteria are the only organic beings which have the property of orienting themselves under the influence of induced currents.

International Congress of Electricians at Geneva. *L'Ind. Elec.*, May 10.—A brief report of the proposed proceedings; it is to be held in Geneva in August in connection with the International Exhibition, and is to continue for four days; the following subjects will be discussed: magnetic units and their names; photometric units and their names; transmission of power to great distances; the protection of high tension lines against atmospheric discharges; the disturbances caused by electric railway currents.

The Nippon Electrical Association (Japan) *Elec. Friend* (Japan) April.—The ninth meeting for this season was held at Tokyo, on April 7; there has recently been a great increase in the interest and membership of this association.

Physical Experiment in Relation to Engineering. A. B. W. Kennedy. Lond. *Elec. Eng.*, May 8.—The beginning of a reprint of his James Forrest lecture, delivered before the Institution of Civil Engineers.

Lightning and Trees. Jonescu. *Elek. Zeit.*, May 7; a brief abstract of an article in a German paper.—In a former article he showed that the liability of trees to be struck by lightning is dependent less on the condition of the soil and the height of the trees than on their nature, and especially on whether they contain oils and starch; those containing oils are rarely struck by lightning, while those containing starch are extremely liable to it. More recently he continued his researches and found that the electric conductivity of the same tree is different at different seasons of the year; many of the trees in the Spring contain oils and in the Fall starch, or the reverse; the amount of water contained in the wood has very little effect.

Relations of Electrical and Mechanical Engineering. Ries. *Eng. Mag.*, June.—An article discussing the two branches of engineering, and pointing out that electrodynamics is a distinct art; while the advanced practitioner in each profession should possess a good theoretical and general knowledge of the other, he should devote himself to the principal details pertaining to his own sphere of labor.

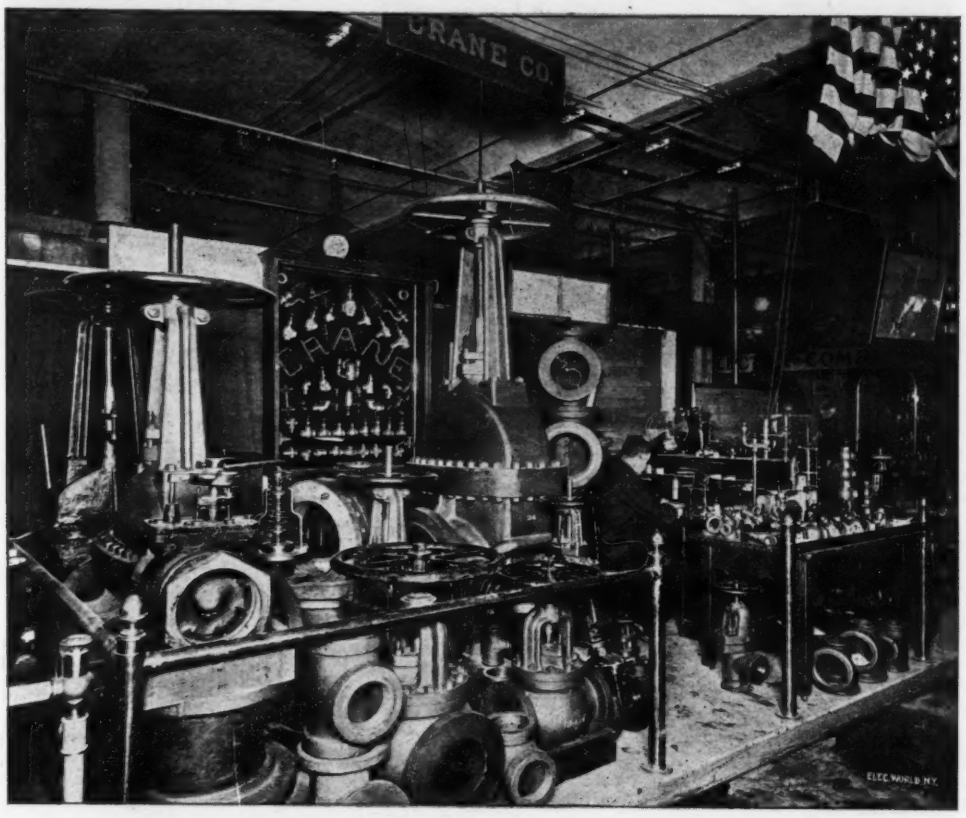
Electrical Journal.—The monthly journal formerly known as *Electrical Industries*, has changed its name to *American Electrician*, and is now published in New York, with Mr. W. D. Weaver as editor; the purpose of the journal will be primarily "to supply practical information for practical men, and also to put before electrical readers in general, information regarding the latest electrical advances, in such form and in language so simple that all may understand without necessarily having previous knowledge on the subject treated. To this end no mathematics will be employed and purely scientific forms of expression will be avoided"; the articles will be prepared by men of thorough practical experience, whose technical opinions carry weight.

Biographical History of Electricity. *Amer. Electrician*, May.—The first article of a series, giving a history beginning with the year 2634 B. C.

Notes of the Exposition.

We present a few more illustrations of notable exhibits that attracted the attention of thousands of visitors at the Electrical Exposition, which closed last Saturday night.

THE CRANE COMPANY, Chicago, made a notable exhibit of extra-heavy gate-valves, globe-valves and angle-valves, from 24 inches in diameter down; also discs, brass valves, mocking-bird whistles, Crane's patent low-water alarm, Crane's patent noiseless back-pressure valves, and blow-off valves. The special feature of the exhibit was an extra-heavy 24-inch gate-valve which is one of the largest steam valves made. All of these extra-heavy goods are tested to 800 pounds pressure before leaving the factory. The illustration shows the completeness of the exhibit. In the centre is seen the 24-inch gate-valve already referred to, while smaller valves of every description occupied much of the space in the booth.



XHIBIT OF THE CRANE COMPANY.

THE ANCHOR ELECTRIC COMPANY, Boston, had a very attractive display of its Anchor incandescent lamp signs. The name of the company and its headquarters were thus shown at the back of the booth, and the sign formed a very attractive feature. Porcelain cut-out boxes, switch bases, sockets, receptacles, push buttons, etc., were disposed on the board at the back of the booth in an attractive manner, and in a show case supplies of all kinds were shown by sample. The accompanying illustration gives but a meagre idea of the appearance of this interesting and very attractive booth.

THE BRYAN-MARSH COMPANY'S exhibit, which was located on the main floor, near the main entrance, and which we illustrate herewith, had some unique features which attracted extraordinary attention. A large board was covered with bung-hole frosted incandescent lamps, certain ones being placed in different circuits and controlled by switches at the back. The lamps on each circuit outline the features of prominent public men and the likenesses were quite accurate. The board was surmounted with a crown—the imperial trade mark—in colored lamps. The company also showed an illuminated diagram, representing the results of a comparative test made on six Bryan-Marsh Imperial lamps and six lamps of a promi-

THE SAFETY INSULATED WIRE & CABLE COMPANY'S EXHIBIT.

nent competitor. The curves of the two tests were shown in red and blue miniature lamps, and the burning-out points in green. In this test one Imperial lamp and four competitor's lamps burned out in 200 hours. Depending from the roof of the booth were ice lamps and bunghole lamps of different colors, and in a showcase was a profusion of lamps of all styles and sizes. Mr. Converse D. Marsh gave much of his time in looking after the exhibit.

Huebel & Manger, Brooklyn, N. Y., the well-known manufacturers of electric gongs, pushes, switches, etc., had a very neat display of samples of the various devices manufactured by the firm. These goods were arranged in an attractive manner on a showboard. This firm's wares are known for their excellence of design and finish, and the company enjoys a high reputation in the trade. An illustration of Huebel & Manger's exhibit is given in one of the accompanying cuts. Mr. McChesney looked after the firm's interests most of the time, and both Messrs. Huebel and Manger were frequent attendants.

The Excelsior Electric Company's, New York, exhibit, on the main floor, is shown in an accompanying illustration. The features of the exhibit were a single-phase, self-starting, synchronous Churchward motor, an Excelsior 120-arc-light dynamo and a Churchward equalizer. Besides these machines there was a full line of dynamos and motors of different sizes, a 50-kw machine being used to run the 120-light dynamo above referred to. Various sizes of commutators were also shown. The synchronous motor, it is stated, has an efficiency of 85 per cent., and starts right up on the full load. Messrs. Hochhausen and Churchward, electrical engineers of the company, spent much of their time at the exhibit.

The Bryan-Marsh Company's Exhibit.

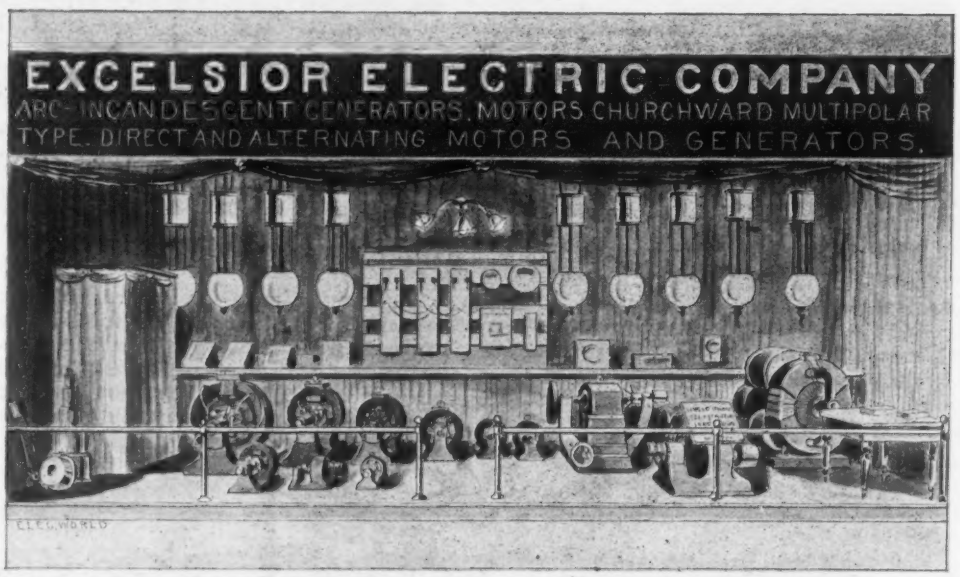
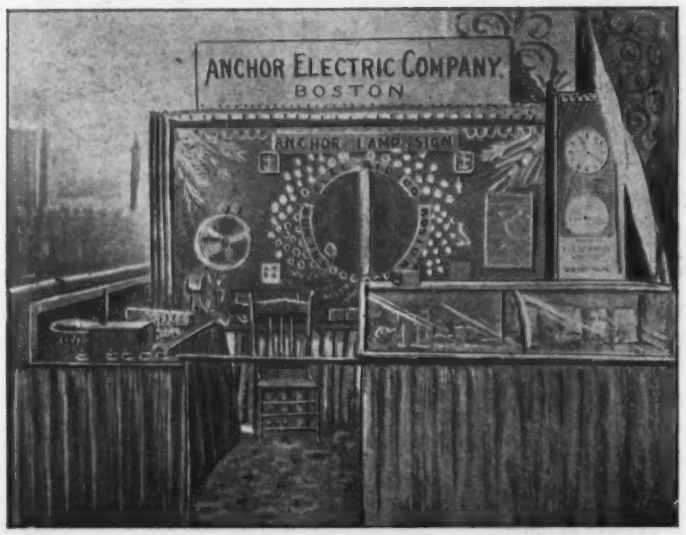

EXCELSIOR ELECTRIC COMPANY
ARC- INCANDESCENT GENERATORS. MOTORS CHURCHWARD MULTIPOLAR
TYPE. DIRECT AND ALTERNATING MOTORS AND GENERATORS.

Exhibit of the Excelsior Electric Company.

The Safety Insulated Wire & Cable Company's exhibit at the Electrical Exposition was one of the largest and most attractive of the many that were to be seen. Arranged along the front of the booth, on counters, were samples of the different makes of wires and cables, and at the back were several framed signs which were electrically illuminated from the back at regular periods of time. These signs announced interesting facts concerning the company's products. The large sign in the centre showed in the same manner the various well-known trade-marks of the Safety Company, set around its title, and on the floor reels of finished wires and cables were displayed in regular order. The draping of the booth was very tasty, and was surmounted by the American coat-of-arms.



The Anchor Electric Company's Exhibit.

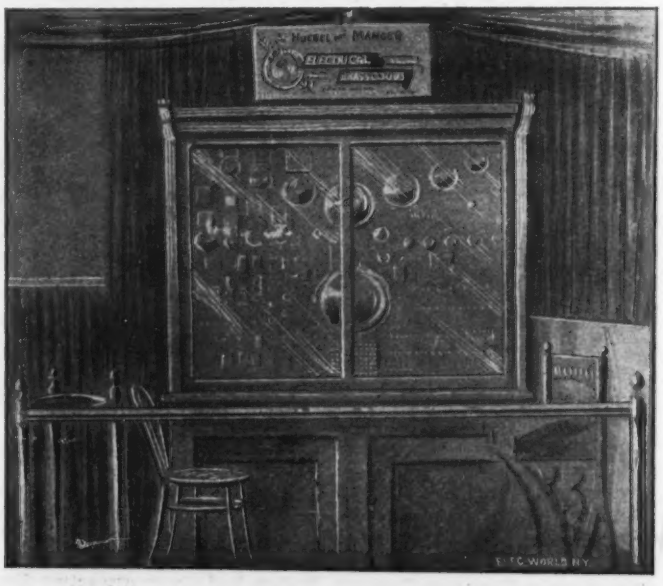


Exhibit of Huebel & Manger.

The Johnson-Lundell Electric Railway.

The accompanying cut illustrates the method of operation employed in the Johnson-Lundell sectional railway system as described in a patent recently issued.

The first impulse of current comes in every case from the storage battery *B*. In the plan shown in the figure the battery is so connected as to discharge through the motor and drive it in case the main current is broken. This enables the car to cross spaces of considerable width without the use of the line current, which is a great advantage in case of intersection with cable roads or similar obstructions, besides which the occasional failure of a contact switch to work will not stop the car. The principal use, however, of the battery, and in the alternative arrangement not shown in the figure the only use, is to start the contact switches to work when the car starts, and to keep them in contact if from a weakening or failure of the line current they tend to cease operating.

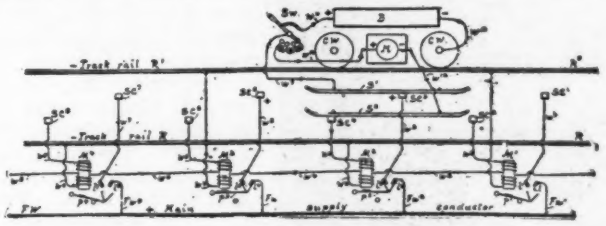


DIAGRAM OF JOHNSON-LUNDELL SYSTEM.

When the car is situated as in the figure, and the motorman starts up by closing the switch *Sw*, the battery current flows over the wire w'', through the switch and motor *M*, to the contact shoe S^2 and the contact block Sc^4. From here it passes over the wire w^4 around the upper coil on the magnet M^2, the lower coil on the magnet M^3, to the rails and back to wheels and the negative pole of the battery by the wire w^{13}. This battery current is sufficient to move the car, and does so if for any reason there is no line current, but under normal conditions the moment the battery current excites the magnets M^2 and M^3, their armatures are drawn up, thus putting the main supply conductor in circuit through the contacts $l^2\ l^3$ and $l^4\ l^5$.

In the position shown, the line current passes up by wire W^3 to contact shoe S^1, and by wire W^9 to switch *Sw*. Here the current divides, and having a somewhat greater E. M. F. than the battery, a small portion passes through the battery to the rails, while the greater portion takes the path over which the battery current has been flowing, namely through the motor, etc. Now suppose the car is traveling from right to left ; the contact Sc^5 is already connected to line in advance of the shoe S^1. Or if the car is traveling from left to right the contact Sc^1 will be connected to line as soon as the shoe S^2 touches the contact Sc^2, for then the current will pass through the upper coil on M^1, lifting its armature and making contact at l'^1. It is plain therefore that the car will travel with equal facility in both directions.

There is one peculiarity of this mode of connection that is not mentioned in the patent. Inasmuch as it is necessary to have two sets of contacts in series even with a track rail return, it does not complicate the contact arrangements at all to have an insulated return. This would, however, render inoperative one of the features described. This feature is that all the magnetic coils used are connected directly to the track rails, so that they cannot possibly be excited by leakage currents, for all leakage currents would pass directly into the rails and not through the coils. The contact $Sc^1\ Sc^3\ Sc^5$, etc., which are connected to the supply conductor, are simple conductors without magnetic coils, so that any leakage therefrom into the ground does not have any other effect than to cause a power loss.

If, however, an insulated return were used, current leaking from the ground into the contacts $Sc^2\ Sc^4\ Sc^6$, etc., might, if of sufficient magnitude, prevent the proper working of the magnets, and by holding up the armatures too long, allow a live section or two beyond the car platform. Still, it is doubtful if the danger from this source would outweigh the advantages of an insulated return, as the leakage would have to be large to hold up an armature which was properly adjusted, and as the car passed along and more sections were left behind, this leakage current would not increase in proportion to the number of exposed contacts, and pretty soon some armatures would drop, so that it is very improbable that any contact would remain alive more than a very short time after the proper time for disconnecting.

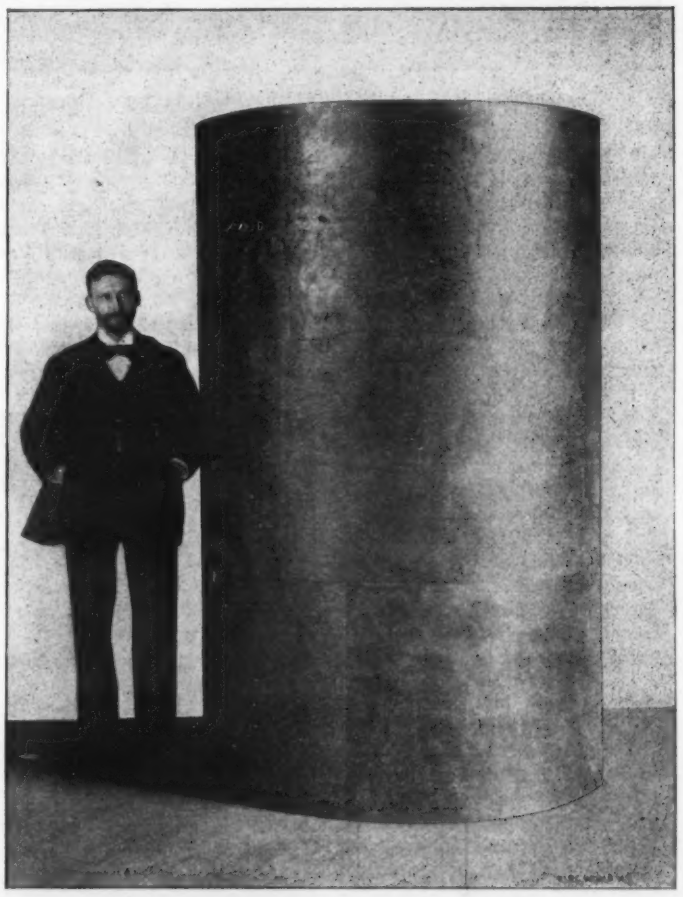
In the alternative form, not shown in the cut, the electrical connections are the same, except that the battery, instead of being connected through the motor to the contact magnets is connected to the magnets direct. In consequence of this arrangement the current from the batteries excites the magnets which happen to be in circuit at any given time, and when the main circuit is closed and the current passes through the motor, the motor current also passes through the magnets. This current will produce a difference of potential between the terminals of the magnets which is proportional to the current strength ; and when this becomes great enough the battery will begin to charge ; below this value the battery will discharge.

This arrangement is intended for heavy railway work where it is not attempted to move the train by the battery. The battery is therefore made to deliver a very large current at a low voltage. Now, when the train is running at about a normal load, the battery is nearly idle or receiving a light charge. When there is a heavy load there is a greater charging rate, but when the load becomes abnormally light, as on descending a grade, the current sometimes becomes so small that there is danger that the magnets which are adjusted to the heavy currents normally used will not respond to the line current, but here the action of the battery comes in and maintains the strength of current in the magnets, however small it may be in the motor.

The necessity for moving the car or train by the battery current is of course much less in regular railway work than in street lines where there are all sorts of obstructions, and the importance of preventing any failure of the contact becomes more important as the speed is increased. In the arrangement for heavy work the contact-plates are put outside the track rails for better insulation, so that higher voltage may be used.

An Exceedingly Large Belt.

The accompanying illustration represents perhaps the largest belt that has ever been manufactured. It is to be used by the Louisiana Electric Light & Power Company, New Orleans, and is 84 inches or 7 feet wide, 150 feet long, is three-ply or seven eighths of an inch thick, and weighs 3300 pounds. In its construction selection was made from 450 whole hides of pure oak tannage, and was made under an hydraulic pressure of 250 tons, for which purpose a special press was constructed. The belt is constructed without rivets, pegs or other fastenings save cement. It is looked upon with considerable pride by its manufacturers, the Chicago



SEVEN-FOOT LEATHER BELT.

Belting Company, 71 South Canal Street, Chicago. The mammoth size of the engine which is to be used in connection with this belt is also of interest. It is an Allis of the Corliss type, and of 3000 horse-power, the fly-wheel alone weighing 85 tons, while the engine itself weighs about 500,000 pounds.

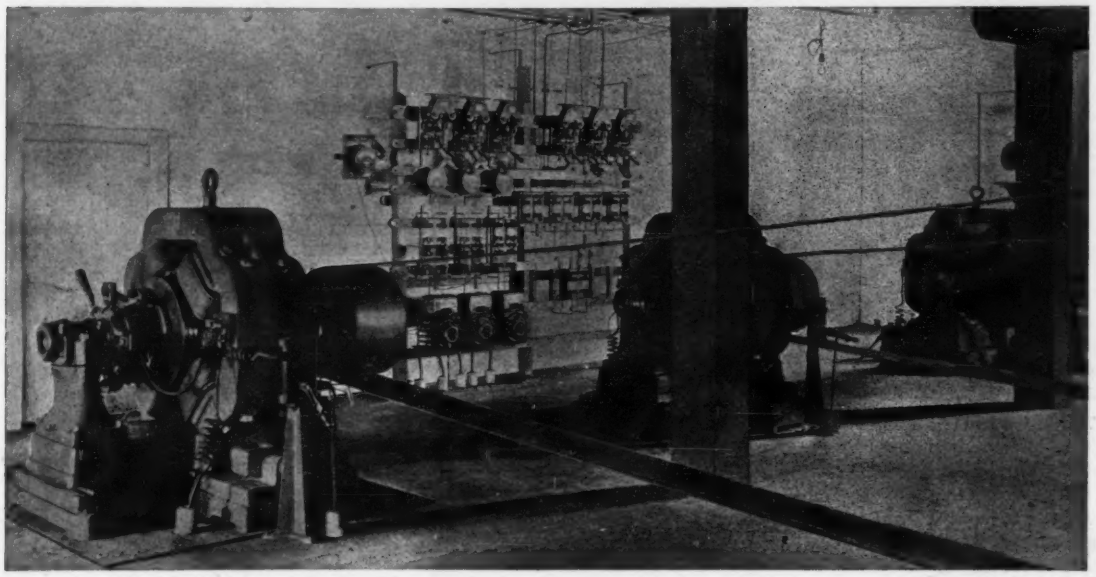
Paterson Wants the General Electric Company's Plant.

An effort is being made in Paterson, N. J., to secure the location of the General Electric Company's plant in that city. Several prominent citizens are actively identified in the project and are ready to subscribe liberally to attain that end. It is claimed that Paterson is so favorably located as a manufacturing centre that the General Electric Company could not find a more convenient situation.

Electrically Operated Mines.

One of the most interesting electrically operated coal properties in the Pennsylvania field is that of the Youghiogheny River Coal Company, at Scott Haven, Pa. The mines in which the different machines driven by electric power are installed are scattered over a large extent of territory.

The power-house is located on the east side of the Youghiogheny River, contiguous to the line of the B. & O. R. R. It was formerly a bonded warehouse, and contains, not only the machinery, but also the stores and offices.



Generating Room.

In the boiler house are three 66-inch by 18 feet tubular boilers, each containing 58 4-inch tubes. Each boiler, built by the Union Iron Works, is coaled through a shute, is independent and has its own stack. Water is pumped by a Downie deep well pump from a well 130 feet deep, and that which is not immediately used is stored in tanks.

The engine room is 74 feet long by 54 feet wide and is separated by a brick wall from the power house. The engine installation consistsof three automatic engines, each 15 x 16 inches, with 72-inch fly-wheels running at 240 revolutions. Each engine is belted to a four-pole, 650-revolution, 100-kw General Electric generator, wound for 500 volts and over-compounded for 10 per cent. loss in the line. The engines and dynamos are erected on brick foundations. The current from the generators is carried under the floor to the switchboard over heavily insulated cables laid on porcelain insulators.

The switchboard is of the skeleton type, divided into two parts, one for the generators and one for the feeders, on a plan similar to that used in the ordinary electric railway stations. The generator board carries three automatic circuit-breakers, three circular dial Weston ammeters, three main double-pole double-throw switches and three field rheostats. The voltmeter is carried on a bracket on the side. The arrangement of the switchboard is such that the plant may be run under the most economical conditions, and every precaution is taken against stoppage in its operation. Two sets of circuits are run—one of which is grounded for haulage work and the other, metallic, for the fans, coal cutters, etc. Any machine may be run on either the metallic or the grounded circuit, and any two or all three may be run in multiple on either circuit. The feeder switchboard carries an automatic circuit-breaker for each of the haulage circuits, a double-pole switch for each pump circuit, fan circuit and the coal cutter circuit, and a double-pole switch for throwing the metallic and grounded bus-bars into multiple. Lightning arresters protecting the generators are placed behind the switchboard. From the power-house the circuits for No. 1 mine are run on poles to the mine mouth. This mine is about 900 feet from the power-house, and the circuit is used to drive fans, pumps, locomotives and coal cutters. The fan is a Capell exhaust fan, 8 feet x 3½, running at 280 revolutions per minute, driven by a belted 25-hp multipolar moderate speed motor, running at 650 revolutions.

All the coal cutting is being done in No. 1 mine by five Jeffrey chain coal undercutters, operated a mile and three quarters from the power-house. The circuit for the coal cutters is a metallic circuit, the other circuits all having earth return. This mine is also provided with a Knowles triplex pump, 6½ x 8 inches, driven by a 7½-hp multipolar motor. The pump, motor and rheostat are mounted on an iron truck, and may be run on the track from place to place in the mine.

The electric locomotive operated in this mine has a length of haul a little over a mile and a quarter. The grades vary from 1 per cent. against loads to .25 per cent. in their favor. The track is laid in 30-pound rails with a gauge of 43½ inches. The overhead construction is of the regular mining type. The pump and haulage circuits are all grounded for the return.

The fact that the various mines are separated from each other by water introduces a novel feature into the installation, and illustrates the flexibility of electric power transmission. For each of the other mines in the Youghiogheny Company's system, current has to be carried under the Youghiogheny River by heavily insulated and armored cables to a small cable house, forming the centre of distribution for the lines running to the mines on the west side of the river.

In No. 4 and the southwest mines electricity is applied to pumping purposes only. The pumps are triplex pumps, similar to those in No. 1 mine, and are driven by two multipolar, slow-speed motors, of 10 horse-power and 7½ horse-power respectively; these pumps are about 8000 feet away from the power house.

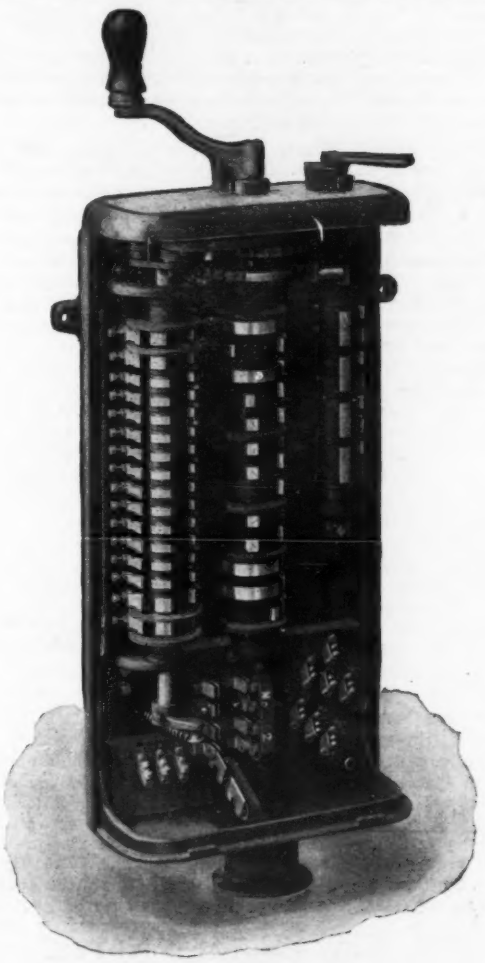
In the Pacific mine the haulage is effected by a locomotive having a drawbar pull of 2500 pounds, with a length of haul of about 5000 feet underground and 800 feet in the open. This mine also contains a pump similar in size to that in No. 1 mine, driven by a 7½-hp motor, located about 16,000 feet from the power-house. A 30-hp motor fan is erected about 1000 feet beyond the pump. The installation of the electrical apparatus in No. 5 mine is not yet completed.

Coal Train.

In the new steel tipple of No. 1 mine, a 7½-hp motor drives a revolving screen and runs an emery wheel for sharpening bits, etc. The installation of electricity in this mine has proved of more than considerable benefit from every point of view. The entire electrical apparatus used in the power-house and in the mines, with the exception of the coal cutters, is of General Electric Company's manufacture.

The Walker "Type E" Street Car Controller.

There is probably no class of apparatus that is operated with as little attention and under as much abuse as that employed in the operation of street cars, and perhaps no single piece of car apparatus should have more consideration than the controller. It has hitherto proved difficult if not impossible to effectually break a circuit of high self-induction, such as that in the motor circuits in railway work, without the formation of an arc, and various methods have been devised for opening such a circuit with the least destructive effect to the terminals or other elements of the circuit. It is a fact well known to electricians that it is much safer in breaking a circuit in which there is high self-induction to do it slowly, drawing a long arc, than to make a quick break, blowing the arc out at once. The more slowly the circuit is opened (consequently the longer arc made) the greater time is allowed for the counter E. M. F. produced by the circuit itself to die down gradually, so as to produce less danger of



STREET CAR CONTROLLER

injury to the insulation or to the breaking terminals on account of the induction "kick."

Among other methods considered, several forms of controller with a magnetic blow-out were tested by the Walker Company, but without complete satisfaction. It was found that in case the circuit is opened very slowly the magnetic field on which the blowing-out of the arc depends is quickly lost, leaving the arc still unbroken, except at a very few contacts. Under such circumstances the arc is liable to spread and cause short circuiting between contacts of the controlling cylinder, or it may even cause a complete grounding of the circuit, resulting in a serious injury to the contact rings of the controlling cylinder and the contact fingers. Furthermore, it appeared to be necessary in a device of this kind to provide separating partitions of some non-combustible insulation material to guard against the spreading of the arc, and these partitions would naturally interfere quite seriously with the inspection of the controller, causing defects to be easily overlooked upon inspection. It is also necessary to provide a magnetizing coil to produce the magnetic field, and this coil, owing to the small amount of room available for the purpose, was apt to become overheated, so as to burn out or ground, thus rendering the blow-out feature non-effective entirely.

After a large number of practical tests, it was found that the principle of drawing a long arc with a relatively slow break gives the most satisfactory and reliable results. Consequently this principle has been adopted in the design of the new controller recently brought out by the Walker Company. In this controller the circuit is broken by a special switch placed in the controller for the purpose, in which the action is relatively slow and the circuit is broken at 28 points, thus, it is claimed, very easily rendering the most severe arc that can be formed in practice entirely harmless both as to spreading to other contacts and as to its effect on burning the breaking contacts themselves.

Another novel feature consists in entirely separating the operation of breaking the circuit from the controlling cylinder itself. The controller consists of two switches, each having its own separate function to perform. The controlling cylinder proper is used simply to make the different combinations required to obtain the proper regulation of the speed of the car. The second switch is also of a cylindrical form, but is used for no other purpose than the complete breaking of the circuit whenever such is required. By reference to the cut it will be seen that the breaking switch, which is shown at the left, has its circuit so arranged that the main current passes first through this switch, before going to the controlling cylinder. In the four lines of contacts shown, the first and third constitute the cylindrical portion of the switch and are in metallic connection each with the one horizontally opposite to it. The second and fourth rows represent the fingers bearing upon the cylinder contacts. It will be seen by tracing out these connections that when the switch is closed the upper contacts shown in outline are short circuited, the current simply passing from top to bottom and then direct to the controlling cylinder. As this switch is opened the fingers leave the lower contacts, shown solid, first throwing the main current through the upper breaking contacts in the series, so that when the fingers leave the cylinder contacts the arc is broken up into as many parts as there are breaking fingers.

The mechanism of the breaking switch is so arranged that with a movement of the controlling handle one quarter of an inch backward, the circuit is completely opened by means of this switch, leaving the controlling cylinder itself entirely dead. The circuit cannot be again closed until the controlling handle has been brought back to the "off" position. After the circuit has been once opened by this slight backward movement of the handle, the controlling cylinder can be moved backward and forward into any position without producing any effect, and it is absolutely necessary to go back to the "off" position before the switch can be again closed. This feature of the controller makes it impossible to drop back from one notch to another in such a way as to put in or take out resistances in the circuit. This is a point that has always heretofore been carefully covered in the instruction to motormen, but at the same time it has been found that such instructions are often disregarded, it being much easier in many cases, if a decreased speed is wanted, to drop back one or two notches, as the case may be, instead of first cutting off the current completely.

There is another point of considerable advantage in the quickness with which the circuit can be opened in case of an emergency. A very slight movement of the handle entirely cuts off the current from the car, thus leaving the motorman free to attend to his brake promptly, with both hands if necessary.

A very simple and effective interlocking device has been adopted in this controller, in which the pawl that indicates the various running positions of the controlling cylinder acts at the same time as a lock between the controlling cylinder and the reversing switch. The controlling cylinder is locked when the reversing switch is in any other position than in either forward or back, and the reversing switch is locked except when the controlling cylinder is at "off" position.

The internal wiring of the controller has also been very much simplified, and as will be seen from the cut, the wiring is entirely open, so that it can be easily seen and gotten at. With this efficient method of breaking the circuit it has been found that separators between the various contacts are entirely unnecessary, consequently the same have been done away with.

The controller casing is sufficiently protected from the entrance of moisture, and the cover, instead of being hinged, is arranged so that it is entirely removed, and can be set one side out of the way when it is desired to get at the internal portion of the controller.

One of the important features of the controller is the ease with which all the parts can be reached when necessary. The breaking cylinder is so designed that when from continued use the contacts have become worn, the cylinder can be turned end for end and the opposite edges of contact brought into service, thus practically completely renewing the cylinder itself. A large number of these new controllers, the Walker Company informs us, have now been put into practical service and are giving the best of satisfaction in every respect.

Data Regarding the Plant to be Installed for the Hartford Electric Light Company.

A water-power of about 3000 hp, situated about 11 miles from Hartford, will be used to drive Westinghouse multiphase alternators, the power to be transformed at the falls to 10,000 volts, and transmitted on a pole line to the Hartford Electric Light Company's station in Hartford, where it will operate motors driving shafting, to which will be belted arc-lighting machines, and from which point alternating current will be distributed for incandescent lighting.

From the station mentioned the current will be carried to the storage-battery station at a pressure of 2000 volts, where it will be transformed to 240 volts and put through a rotary transformer for charging the battery, which will be operated on the three-wire system. The battery will consist of 140 10,000-ampere-hour chloride accumulators.

NEWS OF THE WEEK

Financial Intelligence.

THE ELECTRICAL STOCK MARKET.

NEW YORK, May 30, 1896.

GENERAL ELECTRIC during the week met with a disturbing element in the reported organization of a strong opposition company. The new company, however, states that it is simply in the field for business, and is not formed to antagonize the General Electric or any other company. The report had the effect of knocking the stock down one point. The closing quotations were 1⅝ lower than last week.

TELEGRAPHS.—Western Union showed no special activity during the week, the trading being rather quiet. Only 5407 shares changed hands, and the highest quotation reached was 86¼, while the lowest was 85. Postal Telegraph showed a little more firmness, holders asking a point higher than last week, while bidders were offering lower prices.

ELECTRICAL STOCKS.

	Par.	Bid.	Asked.
Chicago Edison Company	100	118¼	..
Edison Electric Ill., New York	100	96	98
" " " Brooklyn	100	100	102½
" " " Boston	100	135	140
" " " Philadelphia	100	137	..
Edison Ore Milling	100	13	15
Electric Storage Co., Philadelphia	100	32⅞	33
Electric Storage, pref	100	34¼	34⅜
General Electric	100	34	34⅜
General Electric, pref	100	73	75
Westinghouse Consolidated, com	50	..	29½
" " pref	50	..	53
BONDS.			
Edison Electric Ill., New York	105	107	..
Edison Electric Light of Europe	100	75	85
General Electric Co., deb. 5s	100	92½	..
TELEGRAPH AND TELEPHONE.			
American Bell Telephone	100	205	207
American District Telegraph	100	38	40½
American Telegraph & Cable	100	92	95½
Central & South American Telegraph	100	124	127
Commercial Cables	100	150	..
Erie Telephone	100	59½	60½
New England Telephone	100	90½	..
Postal Telegraph-Cable	100	86	89
Western Union Telegraph	100	85	85⅜
ELECTRIC TRACTION STOCKS.			
Baltimore Traction	25	18⅛	18⅜
Brooklyn Rapid Transit		24	25
Brooklyn Traction	100	..	14
" " pref.	100	46	48
Buffalo St. Ry.	100	69	72
Cleveland Electric Ry.	100	..	..
Columbus St. Ry.	100	44	47
Hestonville	100	54½	55
" pref.		..	62½
New Orleans Traction	100	13	15
" " pref.	100	57	60
North Shore Traction	100	29	31
" " pref.	100	79	81
Rochester St. Ry.	..	20	25
Steinway Ry.	..	45	50
Union Railway (Huckleberry)		98	105
Union Traction, rcts $10 pd.	..	14⅛	14¼
West End. Boston	100	71	..
" " pref.	100	..	90
Worcester Traction	100	15½	17
" " pref.	100	88	91
BONDS.			
Brooklyn Rapid Transit 5s. 1945	100	77	79
Buffalo St. Ry. 1st con. 5s.	100	105½	107½
Cleveland Elec. Ry. 1st mtge 5s.	100	100	103
*Columbus St. Ry. 1st 5s.	100	93	97
Rochester St. Ry. 1st 5s.	100	99½	102
Union Railway (Huckleberry) 1st mtge 5s.		102½	105
*Westchester Electric 1st mtge 5s.	100	100	102

* With accrued interest.

TRACTIONS.—Quietness characterized the traction list during the past week, and the transactions were remarkably few. Brooklyn City was dull, due probably to the uncertainty regarding the suit which, it is stated, Mr. Flynn may bring to annul the lease of that company to the Brooklyn Heights.

Special Correspondence.

NEW YORK NOTES.

Office of THE ELECTRICAL WORLD,
253 Broadway, NEW YORK, June 1, 1896.

COMPRESSED AIR CARS.—It is reported that the Metropolitan Traction Company of New York City will conduct experiments with compressed air motors, with a view of introducing the same on the cable lines of the company should the system prove satisfactory in practice.

MR. ALBERT SECHRIST, of Denver, Col, called at the offices of THE ELECTRICAL WORLD last week. Mr. Sechrist is accompanied by his wife on a pleasure trip in the Eastern States, and at the same time he is looking after the interests of a new switch which he hopes to put on the market at an early date.

THE WALKER ELECTRIC COMPANY, it is reported by ex-Gov. Flower, a large stockholder, has no intention of fighting other companies, but is simply out for business. This company, the ex-Governor is credited with saying, has secured the contract for furnishing the electric plant of the Brooklyn Bridge, also for two railways in Chicago, and some equipments for the electric railway there, for roads in Kansas City, Detroit and elsewhere.

OPEN CARS ON BROADWAY.—It is stated that the Metropolitan Traction Company intends to place open cars on the Broadway Cable Line. A despatch from Philadelphia states that the J. G. Brill Company of that city is just about shipping the first lot of 30 open cars for this use. The seats are arranged transversely, and the cars will seat 50 persons comfortably. They are 30 feet in length and will be lighted by Pintsch gas. It is stated that the John Stephenson Company, of New York, is building 30 cars of the same design, which will make 60 in all.

BISHOP POTTER AS MEDIATOR.—Bishop Potter, it is stated, has agreed to present to the New York Council of Mediation and Arbitration the differences existing between Union No. 3 Electrical Workers, and Local No. 5 of the Brotherhood of Electrical Workers. A history of both sides of the quarrel between the two unions will be prepared for the Bishop's use, and in case the Council cannot arrive at a decision, the Bishop will be invited to act personally as umpire. Bishop Potter is president of the New York Council of Mediation and Arbitration

THE MORSE CLUB.—On May 25 the Morse Club held its annual dinner at the Sturtevant House to celebrate the fifty-second anniversary of the sending of the first telegraph message in this country. After the dinner the exercises consisted of speech-making, etc, and an interesting report was read by the historian of the club. It related to all of the recent inventions in telegraphic and electrical lines. The following named gentlemen were elected officers for the ensuing year: President, Marion H. Kerner; vice-president, John B. Taltavall; secretary, John F. Shorey; treasurer, Walter C. Burton. Mrs. Roswell G. Smith, who was formerly Miss Ellsworth, the author of the first telegraph message, was elected an honorary member of the club.

NEW ENGLAND NOTES.

Branch Office of THE ELECTRICAL WORLD,
Room 91, Hathaway Building, 620 Atlantic Ave.,
BOSTON, MASS., May 29, 1896.

MR. FRANK X. CICOTT, manager of the railway department of the Pettingell-Andrews Company, Boston and New York, will sail for Europe on the American line steamer *New York*, to be absent about two months.

WORCESTER POLYTECHNIC INSTITUTE.—By recent enactment of the Massachusetts State Legislature, 20 new free scholarships become available to the next entering class at the Worcester Polytechnic Institute, Worcester, Mass. This makes 43 scholarships, in all, available, being one for every senatorial district in the State, in addition to the 20 or 30 free scholarships to which students from Worcester County only are eligible.

WORCESTER, MASS.—The old City of Worcester, favored by many natural advantages, has gradually developed until now it is the second city in the Commonwealth, and is specially noted for the variety and excellence of her manufactures. She not only ranks well in textile products, but leads in many respects in the branches of iron and steel working. Lathes and drill presses, iron, steel and copper wire, boilers, belting, engines, elevators, organs, looms, textile machinery and a host of other manufactures testify to the energy and ingenuity of her citizens. The names of Knowles, Crompton, Prentice, Reed, Wheelock, Thayer, Washburn & Moen, Graton & Knight, Allen, Stewart, Bigelow, Rice and many others will be recognized as prominent in the field of mechanical arts. The industrial development of the city is not characterized by any boom elements, but is steady and permanent. Her railway facilities give her unusual advantages both for passenger transportation and for the shipment of her various products.

THE WASHBURN & MOEN MANUFACTURING COMPANY.—Any reference to Worcester would seem incomplete without some mention of the large works of the Washburn & Moen Manufacturing Company, whose productions reach all parts of the civilized world and some that are not yet civilized. This business was organized in 1831 by Ichabod Washburn, and since 1835 the works

have developed up to their present stage. During the early days of the wire industry all wire was drawn by hand. At the south works, established by Charles Washburn, it is claimed that the use of the drawing block, instead of the old draw plate, was first introduced into this country. Up to 1884 the products of this company were confined to iron and steel wire, barbed wire for fences, telegraph and telephone iron wire, spring wire, etc. From this date the growth of the electrical industries demanded copper wire, which has since been one of the chief products of the company. The company is now capitalized at $4,000,000. Mr. W. E. Rice is president, P. W. Moen, vice-president, treasurer and general manager, and Mr. C. W. Washburn, secretary. About 4000 men are employed in the Worcester factory. The company has besides a Western factory at Waukegan, Ill., and one also at San Francisco. There are employed upward of 1,500 people. The payrolls at Worcester alone aggregate $35,000 weekly. The products of the company have a high reputation, and it is the largest user of copper for electrical purposes in the country. The company itself also does a large business in insulated wire of all grades, from cotton-covered to the most expensive kind of rubber-covered wire. The insulated wire department, although younger in years, has assumed vast proportions, and is now perhaps second to none. The business of the company for the year just ended, May 6, 1896, aggregated over $10,000,000, an increase of $1,640,000 over the previous year. It should also be said that Worcester is proud of the company, not only on account of its growth and development, and the employment of a large number of her citizens, but also of the high character and standing of its individual members, to whom the city and its institutions owe so much.

WASHINGTON NOTES.

WASHINGTON, D. C., May 29, 1896.

LINE OPENED.—The initial trip over the Arlington branch of the Washington, Alexandria & Mount Vernon Electric Railway was made this week by a large party of the officials of the road and representatives of the Pennsylvania Railroad Company. The road extends from the corner of 13½ Street and E Northwest, Washington, to the principal gate of Mount Vernon. The cars, exclusive of the motor car, which is a little shorter, are about 40 feet long each, and are equipped with every modern convenience, such as is found in the standard day coaches of the Pennsylvania Railroad Company, though they are not so heavy. The seats are somewhat different, they being of a pattern that has not yet, on account of their being so recently patented, come into much use. The Arlington branch is now open for regular travel, and the trains will be run on a regular schedule.

NEW SEASIDE RESORT.—The promoters of the Capital Electric Railway Company are considering a scheme to give Washington a seaside resort that can be reached within an hour from the heart of the city. The proposition is to extend the road from Overlook Inn through Prince George and Ann Arundel Counties, Md., to the Chesapeake Bay. The distance is about 30 miles, through a beautiful country and over good roads. Already the ground has been gone over, and engineers are of the opinion that the scheme is not only possible but practical, and every encouragement is given the promoters of the railway to carry it out. The Capital Railway has just been chartered by Congress to run from the Navy Yard to Overlook Inn, across the Eastern branch, with a line running along Eleventh Street, connecting the Navy Yard branch with the Metropolitan line, and the arrangements have been made to transfer with the Capital Traction Company at the Navy Yard. Mr Arthur E. Randle, of Congress Heights, is at the head of the enterprise, and his contractor says the District end of the railway can be built in 60 days. Work will probably be commenced on it at once, and if the branch of the Chesapeake Bay is considered advisable upon further investigation and survey, a charter will be sought for it from Maryland.

WESTERN NOTES.

Branch Office of THE ELECTRICAL WORLD,
936 Monadnock Building,
CHICAGO, Ill., May 28, 1896.

THE METROPOLITAN ELECTRIC COMPANY is having calls for its catalogue from England, Turkey, the gold fields of Johannesburg, Australia, Central and South America.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, reports that it entirely escaped the effects of the recent cyclone, and therefore will experience no delay in filling orders contracted for.

MR. P. H POLGLASE has recently been appointed manager for the Chicago office of the Adams-Bagnall Electric Company, of Cleveland, O. Mr. Polglase is a very hard worker, and as a salesman has been very successful.

THE UNIVERSITY OF MINNESOTA has recently issued its 1896-97 announcement bulletin of the engineering, metallurgical and mechanical arts departments. Prof. George D. Shepardson is in charge of the electrical engineering department.

THE LELAND STANFORD, JR., UNIVERSITY has just issued its fifth annual register Among the numerous courses of instruction particular attention is apparently paid to the departments of electrical and mechanical engineering, the electrical department being in charge of Prof. Perrine.

THE D. A. KUSEL TELEPHONE MANUFACTURING COMPANY, St. Louis, Mo., is now installed in its handsome new office and factory, 1105 Pine Street, and is doing a rushing business. The company has just closed a contract for 100 telephones and 150 drop-switchboards for Carrollton, Mo.

THE STIRLING COMPANY, manufacturers of the Stirling boilers, has recently issued a pamphlet giving the results of an evaporation test on three Stirling boilers at the Waltham Bleachery & Dye Works, Waltham, Mass. The tests showed that the water evaporation from and at 212 degrees Fahr. was 13.03 per pound equivalent of combustible, the efficiency based upon dry coal being 81.3 per cent.

THE MISSOURI TELEPHONE MANUFACTURING COMPANY is doing the electrical construction for what is known as the Famous Shoe Tower, for the Famous Shoe & Clothing Company, St. Louis. The tower will contain 1000 incandescent lights, and be the largest piece of artistic sign work in the City of St. Louis. This company reports a large quantity of electrical construction work on hand, and is especially busy in the manufacture of telephones and switchboards.

THE ARMORITE INTERIOR CONDUIT COMPANY, Detroit, Mich., states that the favor with which its "Armorite" conduit is meeting is very gratifying. This company is based on the Cummings patents. The tube used in this conduit is iron-armored, and very flexible. The interior is very smooth, which permits of drawing in the wires with great facility. This conduit is the invention of Mr. James F. Cummings, whose underground conduit, manufactured by the Cummings Conduit Company, Detroit, Mich., is also rapidly growing in favor. Both of these companies are doing well, and have unexceptional factory facilities for the production of their goods.

THE OHIO ELECTRIC WORKS, Cleveland, O., is manufacturing an electric bicycle lamp that is warranted not to go out, especially when a policeman happens to be around. In general appearance the new lamp does not differ much from that of the ordinary oil lamp in use, except that it is narrower and the reflector projects further from the surface. The body of the lamp looks more like a small electric battery cell and that is practically what it is—with a lamp and reflector. The battery is easily charged, the materials coming in a small package, and the light, which is supplied by a small incandescent lamp, is backed by a powerful reflector. One charge is said to maintain a light for some hours.

THE ELECTRIC APPLIANCE COMPANY has brought out two more very clever and original advertising schemes—one in the shape of a pad or tablet of blank forms on which can be recorded 30 minute readings of the number of amperes, as shown by the station ammeter. This gives a permanent record of the station load at 30 minute intervals during the entire 24 hours. The other is a complete set of architect's specifications for electric wiring, which can be used as a form for making contracts for electric wiring. These specifications have been carefully drawn by a well-known consulting engineer, and will be found valuable guides in all electric light work. The Electric Appliance Company is prepared to furnish either or both of these free on application.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY, Chicago, reports that its business is rapidly increasing, and that it finds it difficult to keep pace with the orders which are crowding in. The company is receiving reports from various exchanges that it has installed all over the country, complimenting it on the excellent service given by its system. It has recently closed one contract for about 7000 telephones, which, it is claimed, is the largest single contract ever given to any telephone company other than the Bell Company. These excellent results are largely due to the enterprise and good business judgment of the company's President, Mr. James Keelyn, whose untiring efforts in extending the business are deserving of the well-merited success the company has met.

General News.

NEW INCORPORATIONS.

THE FORT WAYNE INTERNATIONAL ELECTRIC COMPANY, New York, N. Y, has been incorporated in West Virginia, by Ernest Thalman, R. T. McDonald, James Marwick and W. H. Bankier, New York City. Capital stock, minimum, $1,000; maximum, $5,000,000.

THE YOUNGSTOWN TELEPHONE COMPANY has been incorporated at Youngtown, O., with a capital stock of $60,000. The incorporators are Mason Evans, Samuel Weil, John R. Wilson and M. T. James, of this city, and Evan J. Evans, Stanton Fox and Stanton Howard, of Massillon.

THE NEW YORK TELEGRAPH & TELEPHONE CONSTRUCTION COMPANY has been organized at Jersey City, N. J., with a capital stock of $100,000. The incorporators are Richard Douglas Kelly, of Jersey City; Merritt S. Middleton, Point Pleasant, and Philip Rand, of New York.

THE TOPEKA WATER COMPANY, Portland, Me., has been incorporated with a capital stock of $15,000, for the purpose of manufacturing and generating gas and electricity for light, heat and power. The incorporators are William C. Eaton, James C. Fox and George F. Noyes, Portland, Me.

THE CARBON ELECTRIC GENERATOR COMPANY has been organized under Maine laws with a capital of $5,000,000, and the directors are as follows: William H. Forbes, Charles P. Bowditch, Alexander Cochrane, F. G. Webster, Robert Windsor, W. W. Jacques and Charles A. Stone, all of Boston.

THE PLATTSBURG TRACTION COMPANY has been incorporated at Plattsburg, N. Y., with a capital stock of $100,000, for the purpose of building an electric road in Clinton County, 8½ miles long. The incorporators are J M. Pierson, H. G. Runkle, M. B. Sneirly, New York City, and G. M. Cole, Plattsburg, N. Y.

THE CLEVELAND ENGINEERING & ELECTRIC COMPANY, Cleveland, O, has been incorporated with a capital stock of $10,000, for the purpose of manufacturing electrical machinery, constructing electric light plants and railways. The promoters are H. F. Fishack, M. J. Carmack, A. J. Hale, T. J. Carmack and J. S. Matson.

THE MISSOURI RAILWAY CONSTRUCTION COMPANY has been incorporated in New York City for the purpose of constructing and equipping railways under contract and to buy and sell the same. The capital stock is $300,000, and the incorporators are Theodore F. Gilman, 62 Cedar Street, New York, G C. Thomas, of Philadelphia, and others.

THE SAN FRANCISCO & SAN MATEO ELECTRIC RAILWAY COMPANY, San Francisco, Cal., has been incorporated for the purpose of purchasing the railway of the above name and operating the same. Those interested are John D. Spreckels, A. B. Spreckels, Nicholas Ohlandt and John A. Buck, of San Francisco. Capital stock, $1,000,000.

THE WARREN, WARE & GILBERTVILLE STREET RAILWAY COMPANY has been incorporated at Warren, Mass., for the purpose of constructing an electric railway from Main Street in Warren to a point in Gilbertville,

a distance of 10 miles. The incorporators are L. L. Currier, of Worcester; J. H. Storrs, of Ware, and others. Capital stock, $150,000.

THE KRAEMER ELECTRIC MANUFACTURING COMPANY has been incorporated at Chicago, Ill., with a capital stock of $100,000 for the purpose of manufacturing, selling and leasing electric motors, machines and devices of all kinds for the purpose of furnishing light, heat and power. The incorporators are Edward Koch, Frank A. Kraemer and Max C. Krueger.

THE FLAT TOP CENTRAL ELECTRIC POWER SUPPLY & TRACTION COMPANY has been incorporated at Bramwell, West Va., with a capital stock of $500,000, for the purpose of building a railway from Roseville to Kimball, West Va. The promoters are L. E. Tierney, Powhatan, West Va.; H. Bert Wright, Kyle, West Va., and Isaac T. Mann, Bramwell, West Va.

THE WALKER COMPANY has been organized in Albany, N. Y. New York, Philadelphia, Boston and Cleveland capitalists are interested. Among them are ex-Gov. Flower, Anthony N. Brady, J. W. Hinckley, Belmont Dallas Sanders, William Rotch, Parker C. Chandler, Frank Billings and Jacob B. Perkins. They have factories in several places, the largest being in Cleveland.

THE AMERICAN MOTOR & TRACTION COMPANY, Pittsburg, Pa., has been incorporated in West Virginia for the purpose of securing franchises for the construction and operation of street railways by steam, electricity, vapor or other motive power. Those interested are H. C. Dohrman, J. P. Edgar, J. H. White, John W. Mathews, Steubenville, O. Capital stock, minimum, $1000, maximum, $5,000,000.

THE SYRACUSE RAPID TRANSIT RAILWAY COMPANY has been incorporated at Syracuse, N. Y., with a capital stock of $4,000,000. The directors of the company are John Alvin Young, of Jersey City, Ansel L. White, George F. Brown, David H. Darling, John B. Summerfield, Edward T. Perine, William H. Cheesebrough, Jr., and S. B. Lawrence of New York City, and Edward H. Tobey, of Brooklyn, N. Y.

THE INTERNATIONAL ELECTRIC TRANSIT COMPANY, New York, N. Y., has been incorporated in West Virginia, for the purpose of acquiring and disposing of patent rights and franchises and contracts for improvements in railway and bridge construction. The incorporators are O. L. Geer, Brooklyn; Louis P. Sefton, New York City, and C. Wroughton Smith, Brooklyn. Capital stock, maximum, $5,000,000; minimum, $1,000.

THE GENERAL TRANSPORTATION COMPANY, Chicago, Ill., has been incorporated with a capital stock of $200,000,000, for the purpose of constructing and operating elevated, underground, street, and surface railways; generate steam, gas and electricity for heating, lighting and power; and manufacture motors, steel rails, steam engines and electrical engines. The incorporators are Adolph Boysen, Henry C. Miller and Edmund F. Burton.

Telegraph and Telephone.

WASHINGTON, MO.- A. A. Tibbe is going to install a telephone exchange in this place.

DELAWARE, O.--The prospects are bright for a telephone connection from Kilbourne to this city.

FAIRMONT, MINN.—The Fairmont Telephone Company's line is to be extended to Welcome and Sherburn.

NAPOLEON, O.—This place is to have a telephone exchange and work upon the line is about to be commenced.

WINCHESTER, N. H.—The people of Winchester are raising money to build a telephone line to Richmond.

JACKSON, MISS.—Subscriptions are being canvassed for in this city to establish a co-operative telephone system.

GALESVILLE, WIS.—The Luce-Veitch Telephone Company has completed its new line to Ettrick, 10 miles north of this place.

PITTSBURG, PA.—There is a movement on foot in this city to secure lower telephone rates from the Bell Telephone Company.

OSWEGO, KAN.—The Parsons Telephone Company has secured a franchise to operate a telephone line in this place for 21 years.

COLUMBIA CITY, IND.—The Home Telephone Company has decided to build metallic lines to South Whitley and Churubusco.

FALL RIVER, MASS.—The Committee of Electrical Control recommends placing under ground all electrical wires about the centre of the city.

HOPE, N. D.—The Union Telephone Company has been organized in this place, and will construct and operate a line to Clifford, Portland and Mayville.

NATCHEZ, MISS.—A plan is being considered to connect Fayette and a large section of territory in that vicinity with Natchez by a telephone system.

FENNIMORE, WIS.—The erection of the line from Lancaster to Boscobe *via* Stitzer and Fennimore has been commenced by the Grant County Telephone Company.

SARANAC, MICH.—The United States Telephone Company has petitioned the Village Council for a franchise to erect and maintain a telephone line within the village.

MILLERSBURG, O.—Arrangements are being made for the extension of a telephone line from this place to Coshocton with intermediate stations at Clarks, Mound and Keene.

PETERSBURG, VA.—The Western Telephone Construction Company, Chicago, has shipped a 400-telephone exchange equipment to the Mutual Telephone Company of this city.

NEW RICHMOND, WIS.—A franchise has been granted to a local company to establish a telephone system in this place. The line will connect with Hudson, Stillwater and St. Paul.

MEMPHIS, TENN.—The Cumberland Telephone & Telegraph Company is making very general extensions of its lines, connecting Memphis with neighboring towns in all directions.

FORT DODGE, IA.—E. H. Martin will put in a telephone exchange here to compete with the Bell Company. A franchise has been granted by the City Council to the Fort Dodge Telephone Company and the work of constructing the lines will be commenced at once.

MILFORD, N. J., is having a telephone exchange put in operation, some 40 subscribers having been obtained. Mr. George Beale, of the New England Telephone & Telegraph Company, Boston, is doing the work. Mt. Vernon and Amherst will also have the service.

BELLAIRE, O.—The Ohio Valley Telephone Company has awarded contracts for telephones and a switchboard as follows: The Western Electric Telephone Construction Company and the Keystone Company, of Pittsburg, each 75 instruments, and the American Electric Company, of Kokomo, Ind., to put in the switchboard.

WASHINGTON, D. C.—Chief Moore, of the Weather Bureau, has invented a device to give telephone subscribers a visual weather forecast. It is a little clock-like instrument to be attached to the telephone, the various weather conditions being indicated on the dial. The indicators are operated from the central exchange, which is connected with the weather office.

THE WESTERN TELEPHONE CONSTRUCTION COMPANY reports a large increase in orders. Recent contracts are: Du Quoin, Ill., 100 telephones; Ashland, Ky., 150 telephones; Bellaire, O., 75 telephones; Metropolis, Ill., 60 telephones; Oberlin, O., 150; Wauseon, O., 100; Barnesville, O., 200 exchange equipment, Rochester, N. Y., 50 telephone equipment; Ticonderoga, N. Y., 150 exchange equipment.

Electric Light and Power.

BATTLE CREEK, MICH.—Bids will soon be received for the electric lighting of this city.

CLAYTON, ILL.—There is talk of establishing a municipal electric lighting plant in this place.

PAWTUCKET, R. I.—An ordinance from the Common Council making an appropriation of $100,000 for an electric lighting plant for the city was read and unanimously passed

MILLVILLE, N. J.—Millville City Council adopted the specification for a new electric light plant, which is to cost $19,300. It will furnish sufficient current for 300 arc lamps.

BROOKLINE, MASS.—The State Senate defeated the bill asked for by the citizens of this town which would have enabled them to establish an electric lighting plant of their own.

MECHANICS FALLS, ME.—Work has been commenced on the new electric light station, which will supply 150 incandescent lamps for street lighting and about 300 for commercial lighting.

SOUTH CHARLESTON, O.—Charleston is to have electric lights. A committee is to visit Plain City, Jamestown and Mount Sterling, to ascertain the cost and best mode of securing the plant.

BAY SHORE, L. I., N. Y.—The Bay Shore Electric Light Company, which a few months ago went into the hands of a temporary receiver, will be sold under foreclosure proceedings on June 30.

CHICAGO, ILL.—Parks and boulevards on the west town will soon be illuminated with electric lights. This was decided upon by the West Park Board. The improvement will cost $85,000.

FREDERICK, MD.—The Board of Aldermen declined the proposition of the Frederick Electric Light & Power Company to furnish the city with lights, and will continue to operate the plant themselves.

DETROIT, MICH.—The contract for installing an electric light plant in the new United States Post Office at this place has been awarded to the Morrison Southern Electric Company, of Baltimore, Md.

WEST HOBOKEN, N. J.—Electric lights have been placed in all the fire houses in this place by the Hudson Electric Light Company, free of cost, in accordance with its contract for the lighting of the town.

ELKHART LAKE, WIS.—The village court granted the Plymouth Light & Power Company a permanent franchise for an electric light and power plant at Elkhart Lake. The work must be completed by July 10.

VICKSBURG, MICH.—This village was recently bonded for $15,000 to build an electric light plant and water works, but an injunction has been issued restraining the Village Council from carrying out the plan.

DETROIT, MICH.—The Latimer Building Company will erect a $55,000 office building on Lafayette Avenue. An independent electric light plant will be installed. W. S. Joy, 39 Hedges Building, is the architect.

EAGLE GROVE, IA.—The electric light plant of this place is a success, and another new building, 40 by 80 feet, is to be built to be used as a power-house. The capacity of the plant is to be enlarged to 3000 lights of 32 candle-power.

ELKHART LAKE, MASS.—At a meeting of the Council a franchise was granted to the Water, Light & Power Company, of Plymouth, to set poles, string wires, etc., prior to furnishing the village with electric lights.

NEWARK, N. J.—The Newark Electric Light & Power Company has purchased a large plot of ground in Lakeside Avenue. The company proposes erecting a model electric lighting plant on its newly acquired property.

DAWSON, GA.—The Supreme Court has decided that the bonds voted some time ago by the people of Dawson for the erection of an electric light plant are valid and now measures will be speedily taken to put in lights.

NEW YORK, N. Y.—The Board of Electrical Control, acting on the application of an electric light company, ordered subways to be built in Columbus Avenue from 59th to 109th Street, preparatory to lighting this thoroughfare by electricity.

NEWTON, N. J.—A contract has been made with the Newton Electric Light & Power Company for all-night burning of 72 arc lights for the next year, beginning June 1 in the Newton streets, for $5000 a year, or less than $70 for each lamp.

MORRISVILLE, PA.—An ordinance granting the privilege of erecting poles and stringing wires to the People's Electric Light & Power Company, of Yardley, has passed first reading. The company proposes to furnish electric lights in Morrisville.

SPRINGFIELD, ILL.—At a special meeting of the Village Board of South Springfield, it was decided to introduce electric lights into the village. Bids will be advertised for and no bid will be considered that is over $70 per light per annum.

DANIELSON, CONN.—The terms of the Electric Light Company were accepted by the Borough Council. It will furnish 43 lights at $75 a light, and the 44th, which is in the park, will be furnished free of charge for the benefit of the borough.

ALTOONA, PA.—William A. Frank, superintendent of the electric light plant, has received the contract for illuminating the front of the Court House, the soldier's monument and the county's triumphal arch, with many colored incandescent lights.

ATHENS, MICH.—Rheubottom & Bond, of Union City, Mich., have just closed a contract with local capitalists here for a complete central station, electric lighting and power plant. It is expected that the plant will be in operation in about 70 days.

COLUMBIA, PA.—Proposals for lighting the borough of Columbia and also the public buildings with electricity will be received by the Light & Water Committee up to 7.30 o'clock P. M., Monday, June 1, 1896. The bids must be for one, two or three years.

KNOXVILLE, TENN.—W. G McAdoo, representing the Mutual Light & Power Company, has secured a contract from the corporations of both North and West Knoxville to furnish them with electric lights for the next 10 years at $80 per light per year.

EDGEWATER, S. I., N. Y.—The Electric Power Company put in a bid to the Board of Trustees of this place, offering to light the streets at $17.50 per lamp. It is probable that the bid will be accepted if the electric light company will agree to furnish lights for the fire-houses free of charge.

BROOKLYN, N. Y.—Mayor Wurster vetoed the bill providing for electric lights of 30 candle-power each, 50 feet apart, on the Brooklyn Bridge to be lighted in foggy weather. The measure was objected to by Chief Engineer Martin, who claimed that the multiplicity of the lights would be a menace to safety.

PHILADELPHIA, PA.—The deal by which the Pennsylvania Heat, Light & Power Company passes into control of all the property and privileges of the Electric Trust was ratified on May 26 by the directors of both concerns. The details of the negotiations were given in the last issue of THE ELECTRICAL WORLD, in the Philadelphia correspondence.

ROCKFORD, ILL.—Ground has been broken for the city's new electric power station, which is to be erected near Chick's mill, on the land owned by R. Emerson. The contract for furnishing all the electrical machinery has been given to the General Electric Company. The dimensions will be 80 x 110 feet, and one story in height, built of solid white brick.

CHATTANOOGA, TENN.—The Chattanooga Light & Power Company decided to move its power plant from the west side of Cameron Hill to a more central location. The company will construct new buildings on the site of the old Morrison Lumber Company's plant, and new and improved machinery will be installed. The plant will be much larger than the present one.

IRVING P. LORD AND W. B. BAKER, owners of the Waupaca, Wis., Electric Light Association, are about to construct a railway between the City of Waupaca and the Wisconsin Veterans' Home and Grand View Hotel, both located at the Chain o' Lakes. The line will be four miles in length, and the power will be furnished from the lighting station of Messrs. Lord and Baker, which is operated by water-power.

ST. GEORGE, S. I., N. Y.—The property of the Electric Power Company has been bought under foreclosure sale by Erastus Wiman in the name of his son, Henry Dun Wiman, for $110,000. The original cost of the property to Mr. Wiman is said to have been nearly $400,000. Against the property there exist claims of less than $150,000, held mostly by Boston bankers. Mr. Wiman will proceed at once to reorganize the company.

LOGAN, UTAH.—The City Council has decided to let the contract for lighting Logan City by electricity to the Hercules Power Company. The city conducted its own electric lighting plant for several years, but the plan has not been altogether a success. By the terms of the contract the Hercules Company agrees to run 25 street lights of 1200 candle-power, with 16 incandescent lamps for inside use, at $950 a year, the contract to be for two years and the company to lease the city's plant for the consideration of $1 a year.

LOUISIANA, MO.—The present contract for lighting the streets of Louisiana, Mo. (a city of about 6000 people, 100 miles north of St. Louis), will expire about Oct. 1, at which time or before the City Council will probably make arrangements for a plant operated under city control, make a contract with the present company, or accept bids from some other party. Louisiana is peculiarly located for the erection of a plant very economically, owing to the city not being scattered. The Mayor of the city is Henry L. Hart, to whom all inquiries should be sent.

PHILADELPHIA, PA.—An explosion in the station of the Powelton Electric Light Company at Forty-third Street and Woodland Avenue, on the evening of May 26, caused complete darkness in the streets of West Philadelphia for an hour. The cause of the accident was the blowing out of the cylinder head of one of the 500-hp engines. The piston-rod, weighing 400 pounds, was blown a distance of 20 feet. The big belts in the station were ruined by the escaping steam. The total damage is estimated at about $3000, one belt alone being valued at $1500. The report of the explosion was heard for nearly a mile.

BOSTON, MASS.—The electrical apparatus and wiring at the pumping station of the Chestnut Hill reservoir have been condemned by the inspector of the wire department. That official reports that the two dynamos used for lighting the station are old fashioned and totally unsuited for the work. They are not self-regulating and the rheostats on the switchboards are mounted directly on wood. He also reports that the wiring is very defective and dangerous, wood cleats being used in many places instead of porcelain and the wires are run through brick walls and timbers without being separated or run through tubing.

THE TEXAS GAS & ELECTRIC LIGHT ASSOCIATION.—The second annual meeting of the Texas Gas & Electric Light Association was held at Dallas on May 12 and 13. Mr. A. E. Judge read a paper on the purposes of the association. Mr. W. H. McGoldrick, superintendent of the San Antonio Gas Company, read a paper on "The Year's Experience with Gas in the Metropolis of Texas," Mr. Fuller a paper on "The Electric Light Companies and Their Consumers," Mr. Thomas D. Miller one on the "Fixed and Variable Expenses in Manufacturing Plants." This latter divided the cost of manufacture between fixed and variable items. The fixed items between interest on investment and depreciation and the variable items were divided into those of wages, salaries and fees, material for manufacture, material for maintenance and repairs, expenses, taxes and insurance. The meeting proved very successful.

THE ELECTRIC RAILWAY.

LOCKPORT, N. Y.—Extensions of the trolley system will soon be started. It is known that a line will be run to Rogers' Grove and thence on to Cold Springs Cemetery, but the other places have not as yet been decided.

NEW HAVEN, CONN.—The Superior Court here entered an order affirming the sale of the Waterbury, Meriden & Cromwell Electric Railway to A Heaton Robertson, who acts in the interest of the New Haven Railway Company.

MILWAUKEE, WIS.—The Milwaukee Electric Railway & Light Company decided to begin at once the work of constructing its proposed extension from the terminus of the present Forest Home Cemetery line to Layton Park, which will be a mile in length.

PATCHOGUE, L. I., N. Y.—The Patchogue & Port Jefferson Railway Company has made application to the Railroad Commissioners for a franchise to build a trolley road across Suffolk County from Patchogue to Port Jefferson over the Waverly route.

ARLINGTON, MASS.—The reduction of fare to five cents from Arlington Heights to Boston has resulted in a large increase in patronage for the electric line and a corresponding decrease in the number of passengers carried by the Boston & Maine Railroad.

SOUTH BEND, IND.—Mr. Fred F. Lee, of Dowagiac, Mich., is vigorously pushing the project which has for its object the construction of an electric railway from Benton Harbor, Mich., to South Bend, running through Niles, Berrien Springs and Buchanan.

PEN ARGYL, PA.—The new directors of the Pen Argyl, Bangor & Delaware Water Gap Electric Railway are thinking of a route from Wind Gap through Pen Argyl, Bangor, East Bangor, Water Gap, Stroudsburg, and Saylorsburg and again to Wind Gap.

DETROIT, MICH.—Chester B. French, promoter of the Detroit & St. Clair River electric road, which is partially built between Chesterfield and Marine City, says the project has by no means been abandoned. He hopes to see the road completed before July.

PITTSBURG, PA.—The Consolidated Traction Company has bought a large piece of ground along the Allegheny Valley Railroad on which it intends to construct a large electric power plant to produce power for all its roads. The price paid for the land was $95,000.

BROOKLYN, N. Y.—The Brooklyn Heights Railway Company has reduced the fare from the Brooklyn Bridge to Jamaica to 5 cents. Connection with all the ferries will be afforded for a 5-cent fare by the new arrangement and transfers will be issued on every line.

PORTSMOUTH, N. H.—Parties from Boston, Mass., have been in Portsmouth, in consultation with Portsmouth capitalists, in relation to an organization for an electric railway from that city to Newcastle, *via* Hotel Wentworth. It is believed that such a road will shortly be built.

LOS ANGELES, CAL.—An ordinance was passed in the Council advertising for sale the Workman street railway franchise, covering territory between Hill and Seventh streets and the Evergreen Cemetery. The proviso was inserted that the Boyle Heights end of the road must be built first.

McKEESPORT, PA.—The Braddock Electric Railway Company made an effort to get the right of way through Wilkinsburg, at a meeting of the Borough Council, but the ordinance was laid on the table. A connection with the Consolidated Traction Company's Duquesne branch is wanted.

PASSAIC, N. J.—The Passaic & Newark Electric Railway Company has succeeded in securing a route through the town of Belleville to Orange, Irvington and other points. It is also stated that the company is considering the feasibility of running a line to Lodi, a distance of six miles from Passaic.

ALBANY, N. Y.—The committee of the Common Council on railways will give a hearing on the application of the Albany, Helderberg & Schoharie Electric Railway Company to build and operate an electric railway in the South End. The chairman of the committee, Alderman Cox, favors the project.

SYRACUSE, N. Y.—The franchise of the Lakeside Railway Company has received the signature of Mayor McGuire. No company has yet been organized, but it is stated that steps will be taken at once in this direction. It is stated that the cost of the road, including power-house, etc., will be $330,000.

BOSTON, MASS.—Under a suspension of the rules the bill to incorporate the Barnstable Street Railway Company was passed by the State House of Representatives to be engrossed. The House also passed the bill extending the time within which the Essex County Railway Company may complete its road.

PHILADELPHIA, PA.—Plans for the first section of the new trolley road to be constructed in Fairmount Park, by the Fairmount Transportation Company were approved and the work of construction will be begun within a few days. Wherever possible the company is to have a grass plot between the tracks.

ST. JOSEPH, MICH.—The stockholders of the St. Joseph & Benton Harbor Electric Railway Company have asked that Charles D. Stuart be appointed receiver and the affairs of the company wound up Fraud and mismanagement are alleged. The company controls six miles of road and is valued at $250,000.

ATLANTA, GA.—At a meeting of the stockholders of the Consolidated Traction Company, President Joel Hurt presented a report showing an income of $491,378.93 from passenger traffic and $5,910.64 from other sources. It was also shown by the report that $2,441.73 had been expended in excess of the receipts.

BROOKLYN, N. Y.—The award of money prizes to the motormen and conductors of the Brooklyn Heights Railway Company for faithful and efficient service was made on May 26. The amount divided was $10,000 among 1139 motormen and conductors. All those who had a clear record of no accidents for the year ending May 1, 1896, received an equal share of the prize-money.

BROOKLYN, N. Y.—Ex-Gov. Roswell P. Flower, with the directors and officials of the Brooklyn Heights Railway Company, recently made a trip over the company's new lines in the Eastern District and over the new Flushing Avenue line to North Beach. As a result of this trip a large railroad loop and other improvements will be made at this resort for the coming season.

NANTASKET BEACH, MASS.—A trial was made on the afternoon of May 23 of the new third-rail electric system. It was laid down on a mile of the Nantasket Beach branch of the New York, New Haven & Hartford Railroad. It is stated that the system worked very satisfactorily, and that it will do away with the overhead trolley wire. The system will be introduced as far as East Weymouth and later through to Boston.

NEW YORK, N. Y.—It is reported that negotiations are pending between the New York & Harlem Railroad Company and the Metropolitan Traction Company for the lease of the Madison Avenue line to the latter for a long term of years. It is stated that the proposition under discussion provides that 3½ per cent. rental shall be paid the first year and ½ of 1 per cent. for each succeeding year until 5 per cent. shall be reached.

VICTORIA, B. C.—On May 26 an electric car on the Consolidated Railway Company's line fell through the Port Ellice bridge into the bay, 75 feet below. Up to the present time 62 bodies have been recovered, and it is thought that in all nearly 200 persons were carried down with the car and bridge. It is probable that 125 people were aboard the car at the time of the accident Several persons on the bridge itself were also lost. The cause of the accident was the collapse of a defective span in the bridge structure. The car was loaded to its utmost capacity with pleasure seekers.

HOUSTON, TEX.—John H. Kirby, master commissioner, sold the property of the Houston Street Railway Company, under an order of the United States Circuit Court in the equity cause of Albert N. Parlin and others, against the Houston City Street Railway Company. The property was purchased by A. H. Hayward, trustee for a syndicate of bondholders, the bid being $100,000. The bondholders had interest amounting to one million and a quarter, but there was no competition, and they secured the property at the mininum price fixed by the court. The bondholders are residents of the New England States.

BOSTON, MASS.—In the United States Circuit Court, Judge Colt, on May 25, granted a hearing in the case of the Thomson-Houston Electric Company *vs.* Albert & J. M. Anderson, on the petition of the complainant for a preliminary injunction against the defendants. The defendants are charged with having infringed the patents held by the complainants on overhead appliances for electric railways. The complainant charges that the defendants make and sell these parts, thereby benefiting by the patent of the complainant. The petition also asks for an accounting of the profits and proceeds of the business done by the defendants. Decision was reserved.

CHICAGO, ILL.—Judge Dunne on May 25 granted a decision in the case of the General Electric Railway Company in favor of the defendant. The Attorney-General filed a bill to enjoin the General Electric Railway Company from beginning operations under an ordinance, the validity of which he attacked on the ground that the necessary frontage had not been secured on many streets and that many signatures were forged and others signed without authority. Evidence was submitted on these points, and it was shown also that many of the consents were purchased. In his decision, Judge Dunne holds that the company's petition was sufficient and its ordinance valid. Therefore, it can begin taking possession of the streets and laying tracks at once. The case will be appealed.

NEW HAVEN, CONN.—In the New London County Superior Court, Judge Thayer handed down what is probably the most important decision rendered in this State on a trolley parallel to a steam road. The New London and Norwich trolley companies have planned and partly constructed a trolley parallel to the New London Northern steam road, between that city and Norwich on the west side of the Thames River, a distance of about 10 miles. The New London Northern company and the New Haven Company opposed it. Judge Thayer now decides against the trolley company. It is the second like decision in this State, the first being rendered last Spring by Judge Hall against a trolley parallel between New Britain and Hartford. In four other cases the trolley companies have won.

THE ENGINEERING ASSOCIATION OF THE SOUTH held its regular meeting on May 14 at Nashville, Tenn., at which the principal paper read was that by Mr. James C. Bradford, entitled "Engineers and Architects, Their Powers and Duties, Considered from a Legal Standpoint" The paper was well received. Among other things which Mr. Bradford said was that in case of doubt between a contractor and a railway where the engineer had to decide, the contractor should be given the benefit of a doubt, owing to the fact that the railway is a corporation and its term of life if limited at all is only limited by the conditions of its charter, while the contractor, if injustice is done him, and a loss thereby caused, has only the term of life usually allotted to man to make good his loss, thereby standing at a very great disadvantage with the railway company.

Trade and Industrial Notes.

THE CAHALL vertical water-tube boiler has met with such success in the plant of the Carnegie Steel Company, at Bagdad, Pa., and also at the Edgar-Thompson Steel Works, that arrangements have been made to clear out the old style of boilers of furnaces A, B and C of the latter works, and replace them by Cahall vertical water-tube boilers, aggregating 5250 horse-power.

WOODHOUSE & RAWSON REORGANIZATION.—A meeting of the share-holders of Woodhouse & Rawson United, Limited, London, England, was held on the 20th of April, and it was resolved that a limited company, with a capital of £50,000, should be formed to take hold of the Manchester Works and the supply business of the above-named company, and that the share-holders and creditors have the right to apply pro rata for the first issue of £10,000 of such capital.

THE SIOUX CITY ELECTRICAL SUPPLY COMPANY, Sioux City, Ia., has been obliged to increase its factory to keep up with orders for telephone goods. Among the many orders now on the books is one for 1000 dials and automatic-central switches for the Automatic Telephone Switch Company, 800-drop manual board for the Home Telephone Company, of Sioux City, to replace a board now in use; a 100-drop manual board and 70 telephones for Sheldon, and 75 telephones for Sibley.

THE WESTINGHOUSE-GENERAL ELECTRIC arrangement with relation to patents, secures to each of those companies a license to the patents of the other, so that the apparatus of both is now manufactured and sold under the protection of the important fundamental patents of Edison, Tesla, Thomson, Brush, Sprague, Van Depoele, Shallenberger and many other inventors. The result of this is that they are willing to give the broadest possible guarantee against loss or damage resulting from patent suits pertaining to apparatus installed by either company.

DESTROYED BY FIRE.—The entire plant of the Weston Engine Company, at Painted Post, N. Y., was destroyed by fire on May 16, together with a large number of engines ready for shipment. The loss was about $100,000. The company has leased a foundry in Corning, N. Y., and will transfer its entire force of molders to that place. Arrangements are also being made to have sufficient machine work done to enable the company to fill its most pressing orders; in the meantime plans for the rebuilding of the plant on a larger scale are being prepared. The new plant will be thoroughly modern.

W. C. STERLING & SON, Monroe, Mich., have been making some large shipments of cedar, telephone, telegraph, electric light and street railway poles to New York points recently, besides securing a large order for shipment to Southern points. The firm has six sorting yards in Northern Michigan, where poles are graded for shipment, besides their Monroe yard, which is claimed to be the largest pole sorting yard in the world At each of the yards a large force of men is kept constantly busy. Sterling & Son have an established reputation for strictly first-class stock and prompt shipments.

"LONG LIFE TO IT."—The well-known toast, "Long Life to It," is made use of by the Electric Arc Light Company, of New York, to emphasize the long life of the Pioneer enclosed arc lamp, which burns from 100 to 150 hours without change of carbons. The "Pioneer" attracted a great deal of attention at the Electrical Exposition by its brightness, steadiness and its entire freedom from shadow. The present management of the Electric Arc Light Company is active and aggressive. The officers know that they have a good thing, and have interested very strong backing to push it to the fullest extent of its merits. Visitors interested in the Pioneer lamp will be cordially welcomed at the elegantly appointed offices and show rooms of the company at 687 and 689 Broadway.

SEVERE TEST.—The operative exhibit of the J. H. McEwen Manufacturing Company, installed at the Electrical Exposition held at New York during the month of May, and consisting of a 40-kw Thompson-Ryan multipolar generator direct-connected to a 10 x 10 McEwen engine, received its due share of attention from the engineering profession and others who visited the show. In order to satisfy those who were interested from a practical standpoint, a water rheostat was provided, so that any desired load up to 50 per cent. beyond the rated capacity of the dynamo could be thrown on and off at will. The normal capacity of the dynamo was 320 amperes at 125 volts, and the test of throwing on and off 450 to 475 amperes instantly with absolutely no sparking and without racing of the engine was a great surprise to all who witnessed the tests.

MAGNETIC CIRCUIT-BREAKERS.—The I-T-E automatic magnetic circuit-breakers, manufactured by the Cutter Electrical & Manufacturing Company, of Philadelphia, have been received with much favor by all those interested in matters electrical, and the underwriters of the cities of New York, Chicago, Boston and Philadelphia have approved them. As is usually the case in all inventions and improvements, the "thing" or feature is some little modification or development which is apparent at first glance, and which, seemingly, should have been thought of before. The letters "I-T-E" in brief represent the salient features of the automatic magnetic circuit-breakers, viz: I-T-E means Inverse Time Element, and represents the basic principle entering into the construction of the device. That is, a circuit protected by this circuit-breaker is opened in less and less time as the circuit approaches nearer and nearer a short circuit. The circuit-breakers are made for switchboards, railways, light and power, motors, house service and storage batteries, in direct and alternating circuits.

Business Notices.

The illustrations in this issue were made by the Photo-Engraving Company, 67-71 Park Place, New York.

BATTERY CUT-OUT CHEAP.—Sensitive, reliable, never requires attention. Gas lighting much improved by its use. Electric Supply Company, of 15 South Warren Street, Syracuse, N. Y.

Illustrated Record of Electrical Patents.

RE-ISSUES.

11,542. ELECTRIC LOCOMOTIVE; J. C. Henry, Denver, Col. App. for re-issue filed Feb. 24, 1896. In combination with the wheels and axles of a car-truck, a frame uniting said wheels and a motor resting by its field-magnets on said frame, and having a bearing on its field-magnets intermediate of their support on the axles adapted to receive the weight of the car-body.

11,543. ELECTRIC LOCOMOTIVE; J. C. Henry, Denver, Col. App. for re-issue filed Feb. 24, 1896. In combination with a four-wheeled motor-truck and a frame thereof, and a motor carried thereby, speed-reducing gear connecting the armature shaft of said motor with the axles, and comprising an internal gear which has bearings on one of the bars of said truck-frame.

11,544. COMBINED GAS AND ELECTRIC LIGHT FIXTURES; L. Stieringer, New York, N. Y. App. for reissue filed Dec. 21, 1894. In a combined gas and electric light fixture, the combination, with a central supporting gas pipe stem or arm, and one or more gas distributing bodies of separate arms for gas-burners and electric lamps supported by such distributing bodies, the arms for electric lamps being closed against the admission of gas thereto, and conductors entering or running out of the electric lamp arms through side openings in such arms outside of such body or bodies.

11,545. AUTOMATIC DEVICE FOR REMOVING RESISTANCE IN STARTING ELECTRIC MOTORS, ETC.; G. H. Whittingham, Baltimore, Md. App. for reissue filed March 6, 1896. In an automatic starting device for electric motors, the combination of a motor; a resistance in series with the armature when starting the motor; a contact-shoe engaging the resistance; and a direct mechanical connection between the armature and the contact-shoe, whereby each revolution of the armature imparts to the contact-shoe a positive movement and gradually cuts out the resistance from the armature-circuit and maintains said circuit at the point of lowest resistance during the run of the motor.

UNITED STATES PATENTS ISSUED MAY 26, 1896.

[In charge of Wm. A. Rosenbaum, 177 Times Building, New York.]

560,513. ELECTRIC RAILWAY; Robert Lundell, Brooklyn, N. Y., assignor to the Johnson-Lundell Electric Company, New York, N. Y. App. filed Dec. 6, 1895. In an electric railway system, permanent or continuous interconnections between electromagnetic switches, the arrangement being such that the electromagnetic switch is given a certain time allowance to close before it is called upon to transmit the propelling current, no matter which way the car or train be moving. (This patent was issued on May 19, but was inadvertently omitted in the last issue of THE ELECTRICAL WORLD.)

560,652. ELECTROMAGNETIC MOTOR; F. M. Schmidt, Brooklyn, N. Y. App. filed Jan. 18, 1896. The combination with the spindle of a fly-fan or like device, of an electromagnet, an armature mounted to oscillate in front of its poles, a metal ring with an insulating-segment capable of partial rotation, and having two arms projecting on opposite sides of the armature or a pin thereon, a brush bearing on the ring, and adapted in the movement of the armature to make and break the circuit through the magnet, a pawl operated by the armature, and a train of reducing-gears connected with the fan-spindle and rotated by the pawl.

560,658. CONTROLLER FOR ELECTRIC CARS; E. A. Sperry, Cleveland, O. App. filed March 20, 1896. The combination with a controller-cylinder, of a switch for reversing the armature connections, a rocking device arranged to actuate said reversing-switch, a connecting-rod arranged to be actuated by the cylinder, and means for engaging said rod with and disengaging it from the rocking device.

560,667. INCANDESCENT LAMP SOCKET; H. C. Wirt, Schenectady, N. Y. App. filed Feb. 17, 1896. A molded base for incandescent lamp sockets, formed with pillars of a similar or standard length, and with a central transverse-recess or open portion, extending from top to bottom clear across the base and shouldered portions to receive the key-frame, key, and its spring, and of such depth, with reference to the pillars, as to insure the electrical connection of the key with the contact of an incandescent lamp, in combination with said key-frame, key and spring, and a central electrical connection for securing the base to the lamp mounted in said base below the ends of said pillars, and projecting beyond the latter.

560,671. ELECTRIC ARC-LAMP; T. E. Adams, Cleveland, O. App. filed Jan. 4, 1896. In an arc-lamp, the combination with the lamp-arm and an arc-inclosing globe, of a plate made integral with the lamp arm and forming a cover for said arc-inclosing globe, said plate or cover having a hole for the passage of the upper carbon of the lamp.

560,678. ELECTRIC RAILWAY; H. Brandenburg, Chicago, Ill. App. filed March 11, 1895. In an electric railway, the combination with a slotted tubular conductor, of a trolley having a beaded plate, and a sleeve carrying a multiplicity of contacts mounted on said bead.

560,679. APPARATUS FOR PRODUCING MUSICAL SOUNDS BY ELECTRICITY; B. Breed, Philadelphia, Pa. App. filed Nov 20, 1894 A series of musical strings in combination with a series of electromagnets arranged in parallel and connected with a source of electric energy, and a system of two-way switches controlling the current to the electromagnets.

560,703. ELECTRIC VALVE; C. L. Fortier, Chicago, Ill. App. filed Oct. 10, 1892. In an electric valve the combination of a valve-case provided with connections having valve seats and openings within said case, an electromagnet, means for changing the polarity of said magnet, a polarized armature pivoted within said case in the field of said magnet and provided opposite the seats and openings in said connections with valves which are adjustably connected with said armature so as to admit of varying the distance between them and their seats, whereby sticking of the armature to the cores of the magnet is prevented and the closing of the valves is insured.

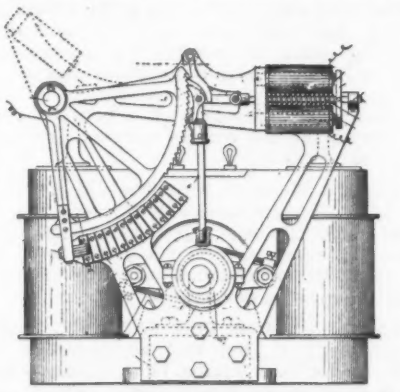
560,721. ELECTRIC RAILWAY; E. H. Johnson, New York, and R. Lundell, Brooklyn, N. Y. App. filed Oct. 15, 1895. The method of disconnecting a sectional trolley conductor from circuit with a current main or lead, when the circuit connections between said conductor and main are due to leaking currents, which consists in conveying the leaking currents around the switching mechanism, and thereby causing said switching mechanism to assume its normal or open position.

560,735. ALTERNATING-CURRENT GENERATOR; W. S. Moody, Lynn, Mass. App. filed Jan. 17, 1896. In combination, an alternating-current dynamoelectric machine, an exciter-armature in circuit with its field-magnet winding, a coil of high resistance upon the field-magnets of the exciter, an external source of current for the coil, and another coil upon the field-magnets, the latter coil deriving its energy from the alternator.

560,737. COMMUTATOR BRUSH; W. H. Morgan, Alliance, O. App. filed Feb. 20, 1895. A commutator brush or shoe, comprising a series of pivotally-supported sections, said section being adapted to yield at one end, and said sections being so disposed that the yielding end of one section will be adjacent to the unyielding end of the next section.

560,757. BUSY SIGNAL FOR TELEPHONE LINES; C. E. Scribner, Chicago, Ill. App. filed Aug. 17, 1895. The combination with the lever of an automatic telephone-switch, of an indicator adapted to be set by the movement of the telephone switch, a detent adapted to be set by the movement of the telephone switch, a detent adapted to engage the indicator and an electromagnet controlling the detent.

560,761. TELEPHONE CIRCUIT; J. S. Stone, Boston, Mass. App. filed March 13, 1896 The combination with a telephone-circuit, of a generator and a relay in a permanent bridge between the circuit-conductors, the generator being interposed between the coils of the relay; and a local circuit, including a battery, a line lamp-signal controlled by the relay, and means for shunting the signal when connection is made with the line.



NO. 11,545. AUTOMATIC DEVICE FOR REMOVING RESISTANCE IN STARTING ELECTRIC MOTORS.

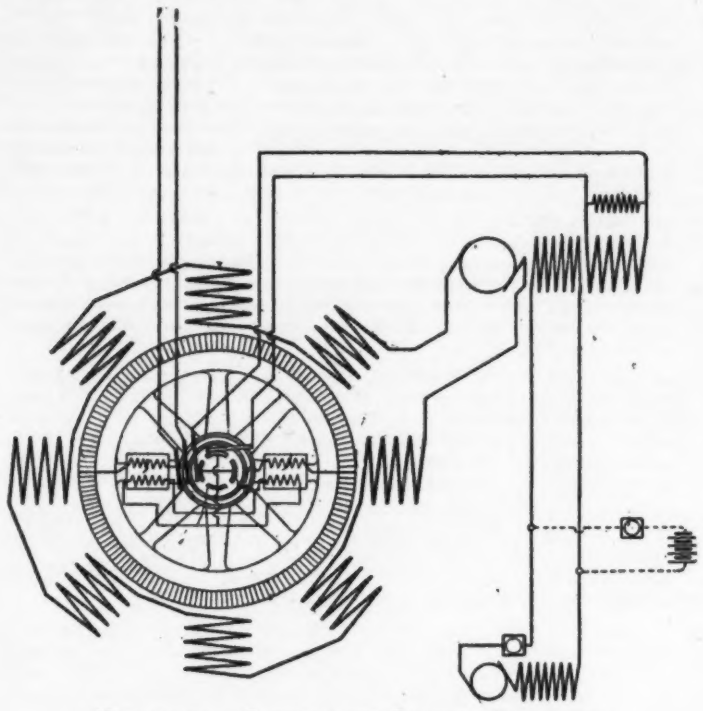
560,762. TELEPHONE CIRCUIT AND APPARATUS; J. S. Stone, Boston, Mass. App. filed April 2, 1896. The combination in a system of telephone circuits with a common transmitter current battery and two telephone circuits connected in series therewith, each including a telephone receiver and a telephone transmitter supplied with current thereby; of a device having a relatively high apparent resistance or impedance in series in each of said circuits, and with the said battery, which device also operates as a repeating coil.

560,766. CONTROLLABLE SWITCH BOX; J. Van Vleck, New York, N. Y. App. filed Jan. 3, 1896. In combination with an electric mechanism having contacts, an inclosing case for said mechanism having a detachable cover, the said cover having its inner surface inwardly inclined to a downwardly-projecting point so disposed that moisture condensing on said surface and dropping from said point will not fall upon said contacts.

560,772. ELECTRICAL DISTRIBUTING SYSTEM; R. R. Bowker, Brooklyn, N. Y. App. filed Feb. 27, 1896. In an electric distributing system, a supply-station, a controllable switch-box at a distance therefrom, a street-conductor leading from said station to said switch-box, two branch street-conductors also leading from said switch-box, and a means for controlling said switch-box from said station, whereby the supply-current may be directed into either of said branch conductors.

560,792. ELECTRIC ARC-LAMP; J. H. J. Haines, New York, N. Y., and A. B. Fernald, Jersey City, N. J. App. filed Jan. 7, 1896. The combination with the feed-magnet of a lever operated thereby, clutch mechanism mounted to move freely and rotate upon studs projecting from said lever, and a fixed releasing device for the clutch mechanism.

560,807. CONDUIT ELECTRICAL RAILWAY; W. Lobach, Chicago, Ill. App. filed April 23, 1894. In a conduit electric railway system, a trough extending along the track, a working conductor supported in said trough, fluid insulating material in said trough, and surrounding said conductor, and a collecting device extending from the car on said railway and making contact with said conductor.



No. 560,735.—Alternating-Current Generator.

560,819. AUTOMATIC FUSE; H. C. Reagan, Jr., Philadelphia, Pa. App. filed Sept. 6, 1895. In an automatic fuse a movable plate and disc, a support therefor, a contact on said support, heads mounted on said plate and disc, and fuses intermediate of said heads, and acting to hold the same in normal position, and release them when the fuse is blown in combination with means for imparting motion to said disc.

560,821. ELECTRIC CUT-OUT; J. C. Reynolds, New York, N. Y. App. filed Jan. 25, 1896. As an improved article of manufacture, a cut-out for electrical uses, comprising an open-ended hollowed casing of insulating material in the hollow thereof for the attachment of the conductors, a cover of insulating material adapted to press upon and clamp together the conductors at each of the respective studs so as to effect electrical contact between the terminal and fuse-wire at the stud, and means for binding the cover firmly to the casing.

560,828. CABLE CLIP; P. Wunderle, Providence, R. I. App. filed March 24, 1896. The combination with a cable clip, of a supporting hook adapted to secure the ends of the clip-band together, and having a curved heel provided with bent-up edges projecting from the lower end of the hook, whereby the weight of the suspended cable acts to force the heel portion of the hook into the covering of the cable.

560,841. CURRENT COLLECTOR FOR ELECTRIC RAILWAYS; A. N. Connett, Washington, D. C. App. filed Jan. 17, 1896. A traveling contact or current collector for electric railways comprising a hanger, oppositely-disposed contact shoes, an intervening toggle, a spring connection between the toggle and hanger, and supporting-links for sustaining the shoes independently of the spring connection.

560,845. TELEPHONE EXCHANGE SYSTEM; W. W. Dean, St. Louis, Mo. App. filed April 3, 1896. The combination with a metallic circuit, having telephones connected in different portions thereof, of a retardation-coil bridging between the sides of said circuit between the telephones, said retardation-coil being provided with two uniform coils of wire, said coils surrounding the core of the induction-coil and being laid about the same, side by side, the inner ends of said coils being united, whereby an electrical connection is formed, through the medium of said coils, between the sides of the circuit, while the alternating or voice currents are prevented from being shunted across the said connection.

560,852. STATIC ELECTRICAL MACHINE; C. M. Hollopeter, Fostoria, O. App. filed July 19, 1895. In a static electrical machine, a rectangular frame consisting of opposite insulated pairs of frame conductor rods, stationary and revolving generator-plates mounted within the frame, and swinging, adjustable prime conductors pivotally connected respectively with the opposite pairs of frame-rods.

560,861. MULTIPLE TELEPHONY; F. A. Pickernell, Newark, N. J., and F. S. Perrin, New York, N. Y. App. filed March 21, 1896. The combination of a metallic telephone line-circuit, a second main metallic telephone-circuit having for one of its sides or conductors a portion of both of the conductors in parallel of the first circuit, and a double-wound electromagnet resistance or choking-coil having its two windings serially but opposingly connected in the conductors of the said first circuit at points beyond or outside the portion of them which forms one side of the second circuit, and adapted thereby to offer a minimum impedence to currents flowing through the conductors of the said first circuit in series, and a maximum impedance to currents flowing through the same conductors in parallel.

560,894. CURRENT COLLECTOR FOR ELECTRIC RAILWAY; A. N. Connett, Washington, D. C., and J. S. Detrick, Baltimore, Md. App. filed Jan. 17, 1896. A traveling contact or current collector for electric railways, comprising a pair of contact shoes, springs for holding the shoes in yielding contact with the supply conductors and pivoted supports for the shoes independent of the springs, said supports extending in reverse directions from fixed pivotal points to bring the shoes opposite each other.

560,903. ELECTRIC RAILWAY; W. H. Jordan, Brooklyn, N. Y. App. filed Jan. 17, 1896. In an electric railway, the combination with a working conductor having insulated sections, a feed wire extending along the line and connected at intervals with the working conductor and two connections between the feed wire and the insulated sections, one of said connections containing signaling devices and the other connection being of high resistance, whereby when a car enters an insulated section the current for the motor will pass through the signaling devices and operate the same.

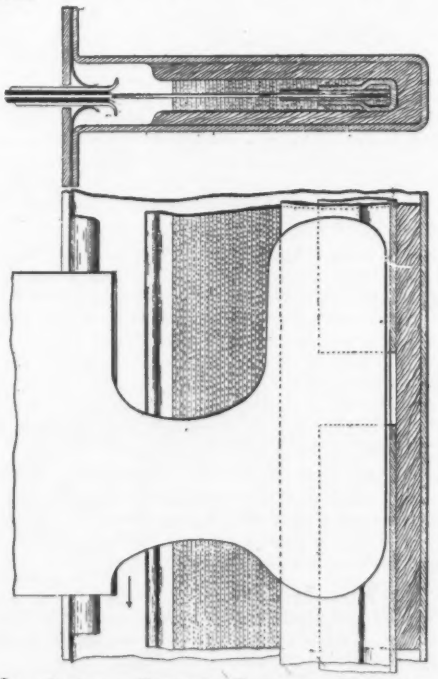
560,917. ELEVATED ELECTRIC RAILWAY; J. H. McGurty, Jersey City, N. J. App. filed June 13, 1895. In an electric railway, the combination with a track, an electric conductor, and an electrically propelled car, of a switch provided on the car and adapted to be moved horizontally, a trip disposed at each side of the track to engage with and move the switch laterally to break the circuit, and a second trip arranged at the opposite side of the track to engage with the said switch and move it laterally to a normal position and establish the circuit.

560,921. THERMOMETRIC CIRCUIT-CLOSER OR ALARM; R. Pearson, London, England. App. filed Sept. 3, 1895. A thermostatic electric circuit-closer consisting of a thermometer containing a mercurial column, two platinum wires forming the terminal contacts of the circuit and both entering the thermometer-bore at such a point that neither is in contact with the mercury column at normal temperatures, and an insulating fluid contained in the bore between the mercury and said contacts, said insulating fluid consisting of creosote free of fatty matter and having a boiling point of about 400 degrees Fahr.

560,988. ELECTRIC RAILWAY SYSTEM; N. J. Halpine, United States Navy. App. filed Feb. 1, 1893. The combination with a double electromagnetic trolley provided with cylindrical magnets and furnished with an electrical contact wheel, of a cord or chain connected with double trolley and with the angled foot lever pivoted to the platform of the car, and connected with the trolley-operating cord or chain.

561,002. SYSTEM OF ELECTRICAL DISTRIBUTION; P. O. Keilholtz, Baltimore, Md. App. filed Feb. 29, 1896. A system comprising a motor and a dynamo, the field of the motor being in circuit with the armature of the dynamo, auxiliary windings on the motor-field in series with the field of the dynamo and means for revolving the armatures of the motor and dynamo in unison.

561,046. ELECTROTHERAPEUTIC APPARATUS FOR TREATING DEAFNESS; S. J. Collier, Chicago, Ill. App. filed Oct. 22, 1895. A device for treating deafness, comprising a box or case, a galvanic battery, an induction coil, and an electromagnetic sounder, both the coil and sounder being arranged in the box and in a circuit of the same battery, a switch for sending the current to either the induction-coil or sounder, or both at the same time, tubular ear-pieces having a tubular connection with the interior of the box, and wires leading from the terminals of the secondary coil to the two ear-pieces.



No. 560,807.—Conduit Electric Railway.

561,073. LIGHTNING ARRESTER; W. Cooper, Schenectady, N. Y. App. filed Sept. 23, 1895. The combination with the air-tight box, of terminals arranged therein, a weak cover provided for said box, one of said terminals being provided upon the box, and the other upon the cover, a gap being provided between the terminals, and said cover adapted to be blown off when gas is formed by the burning of an arc between said terminals.